Ocean Surveyor
Ocean Observer
Commands and Output Data Format

RD Instruments
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P/N 95A-6022-00 (December 2002)

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Ocean Surveyor Commands and Output Data Format

1 Introduction

This guide defines the commands and Output Data Format used by the Ocean Surveyor/Ocean Observer. Most ADCP settings use the factory-set values (Table 2, page 5). If you change these values without thought, you could ruin your deployment. *Be sure you know what effect each command has before using it*. Call RDI if you do not understand the function of any command.

> **NOTE.** This guide applies to Ocean Surveyor/Observer firmware version 23.11. When new firmware versions are released, some commands and/or output data formats may be modified or added. Read the README file on the upgrade disk, or check RDI's web site for the latest changes.

2 Data Communication & Command Format

You can enter commands with an IBM-compatible computer running a terminal emulator program such as RDI's *BBTalk*. The ADCP communicates with the computer through an RS-232 or RS-422 serial interface. We initially set the ADCP at the factory to communicate at 9600 baud, no parity, and 1 stop bit.

The ADCP wakes up as soon as power is applied. Sending a BREAK signal from a terminal/program awakens the ADCP (press **End** using *BBTalk*). The BREAK signal must last at least 300 ms. When the ADCP receives a BREAK signal, it responds with a wake-up message similar to the one shown below. The ADCP is now ready to accept commands at the ">" prompt from either a terminal or computer program.

```
Ocean Surveyor Broadband/Narrowband ADCP
RD Instruments (c) 1997-2000
All rights reserved
Firmware Version 23.xx
>
```

3 Command Input Processing

Input commands set ADCP operating parameters, start data collection, run built-in tests (BIT), and asks for output data. All commands (Table 1, page 3) are ASCII character(s) and must end with a carriage return (CR). For example,

```
>WP1<CR> [Your input]
```

If the entered command is valid, the ADCP executes the command. If the command is one that does not provide output data, the ADCP sends a line feed <CR> <LF> and displays a new “>” prompt. Continuing the example,

```
>WP1<CR>      [Your original input]
>             [ADCP response to a valid, no-output command]
```

If you enter a valid command that produces output data, the ADCP executes the command, displays the output data, and then redisplays the “>” prompt. Some examples of commands that produce output data are ? (help menus), PS (system configuration data), and PA (run built-in tests).

If the command is not valid, the ADCP responds with an error message similar to the following.

```
>WPA<CR>                                     [Your input]
>WPA  ERR 002:  NUMBER EXPECTED<CR><LF>      [ADCP response]
>
```

After correctly entering all the commands for your application, you would send the CS-command (or T) to begin the data collection cycle.

3.1 Data Output Processing

After the ADCP completes a data collection cycle, it sends a block of data called a *data ensemble*. A data ensemble consists of the data collected during the ensemble interval (see TE-command). A data ensemble can contain header, leader, velocity, correlation magnitude, echo intensity, status, and bottom track.

ADCP output data can be in either hexadecimal-ASCII (Hex-ASCII) or binary format (set by CF-command). The Hex-ASCII mode is useful when you use a terminal to communicate with, and view data from the ADCP. The binary mode is useful for reducing the ensemble size to as small as possible for use with a computer program. You would not use the binary mode to view data on a terminal because the terminal could interpret some binary data as control codes.

When data collection begins, the ADCP uses the settings entered last (user settings) or the factory-default settings. The same settings are used for the entire deployment.

The ADCP automatically stores the last set of commands used in RAM. The ADCP will continue to be configured from RAM until it receives a CR-command or until the RAM loses its backup power. If the ADCP receives a CR0 it will load into RAM the command set you last stored in non-volatile memory (semi-permanent user settings) through the CK-command. If the ADCP receives a CR1, it will load into RAM the factory default command set stored in ROM (permanent or factory settings).

Table 1 gives a summary of the ADCP input commands, their format, and a brief description of the parameters they control. Refer to the listed page for more information about a command. Table 2, page 5 lists the factory default command settings.

Table 1: ADCP Input Command Summary

Command	Description
?	Shows Command Menu
<BREAK>	Interrupts or wakes up Ocean Surveyor and loads last settings used
V	Display banner
BAnnn	Bottom Track Amplitude Threshold (0 to 255 counts)
BCnnn	Bottom Track Correlation Threshold (0 to 255 counts)
BEnnnn	Bottom Track Error Velocity Threshold (0 to 9999 mm/s)
BPn	Bottom Track Pings (0 = disable, 1 to 999 = number of pings)
BXnnnn	Bottom Track Maximum Tracking Depth (0 to 9999 dm)
CBnnn	Serial Port Control (Baud Rate/Parity/Stop Bits)
CFabcde	Flow Control (a = ensemble cycling, b = ping cycling, c= binary/ASCII, d = serial port, e = not used)
CK	Keep Parameters as User Defaults
CRn	Retrieve Parameters (0 = User, 1 = Factory)
CS	Start Pinging
CXn,n	Trigger Mode (In, Out)
EA±nnnnn	Heading Alignment (-179.99 to 180.00)
ECnnnn	Speed of Sound (1400 to 1600 m/s)
EDnnnnn	Depth of Transducer (0 to 65535 decimeters)
EEnnnn nnnn	Attitude Data Output and Interpolation
EF±nn	External Pitch/Roll Factor (-99 to 99)
EHnnnnn,n	Heading Angle (heading (-179.99 to 180.00); frame (0 = instrument coordinates, 1 = ship coordinates))
EI±nnnnn	Roll Misalignment Angle (-179.99 to 180.00)
EJ±nnnnn	Pitch Misalignment Angle (-179.99 to 180.00)
EP±nnnn, ±nnnn,z	Tilts (pitch (-179.99 to 180.00), roll (-179.99 to 180.00), frame (0 = instrument coordinates, 1 = ship coordinates))
ESnn	Salinity (0 to 40 parts per thousand)
ET±nnnn	Temperature (-5.00 C to +40.00C)
EUn	Orientation (0 = Down, 1 = Up)
EV±nnnnnn	Heading Bias (-179.99 to 180.00)
EXnnnnn	Coordinate Transformations
EZnnnnnnn	Sensor Source (c; d; h; p; r; s; t, u); (0 = manual, 1 = transducer, 2 = synchro)
LC	Clear Fault Log
LD	Display Fault Log

Command	Description
LL	Display Fault List
NAnnn	Narrow Bandwidth Profiling Mode False Target Amplitude Threshold (0 to 255 counts)
NDabc def ghi	Narrow Bandwidth Profiling Mode Data Out (a = velocity, b = power, c = echo intensity, d = percent good, e = status f to i = reserved)
NEnnnn	Narrow Bandwidth Profiling Mode Error Velocity Threshold (0 to 9999 mm/s)
NFnnnn	Narrow Bandwidth Profiling Mode Blanking Distance (0 to 9999 cm)
NNnnn	Narrow Bandwidth Profiling Mode Number of bins (0 to 128 bins)
NPnnn	Narrow Bandwidth Profiling Mode Number of Pings (0 to 999 pings)
NSnnnn	Narrow Bandwidth Profiling Mode Bin Size (1600 to 6400 cm for 38 kHz, 800 to 3200 cm for 75 kHz, 400 to 1600 cm for 150 kHz)
PA	Runs Built-In tests
PCn	Show Sensor Data (0 = help, 2 = sensor data)
PDn	Data Stream Select (n = 0)
PSn	Display System Parameters (0 = Sys Configuration, 1 = fixed leader, 2 = variable leader, 3 = reserved, 4 = ping sequence)
PTn	Diagnostic Tests (0 = help, 3 = receive path, 5 = electronic wrap around, 6 = receive bandwidth)
TC	System Timer Value
TEhh:mm:ss.ff	Time per Ensemble (hh = hours, mm = minutes, ss = seconds, ff = hundredths of seconds)
TPmm:ss.ff	Time Between Pings (mm = minutes, ss = seconds, ff = hundredths of seconds)
TSyymmddhhmmss	Set System Date and Time (Year/Month/Day, Hour: Minute: Second)
WAnnn	Broad Bandwidth Profiling Mode False Target Amplitude Threshold (0 to 255 counts)
WCnnn	Broad Bandwidth Profiling Mode Correlation Threshold (0 to 255 counts)
WDabc de0 000	Broad Bandwidth Profiling Mode Profile Data Out (a = Velocity; b= Correlation; c = Intensity; d = percent good, e = Status)
WEnnnn	Broad Bandwidth Profiling Mode Error Velocity Threshold (0 to 9999 mm/s)
WFnnnn	Broad Bandwidth Profiling Mode Blanking Distance (0 to 9999 cm)
WNnnn	Broad Bandwidth Profiling Mode Number of bins (1 to 128 bins)
WPnnn	Broad Bandwidth Profiling Mode Number of Pings (0 to 999 pings)
WSnnnn	Broad Bandwidth Profiling Mode Bin Size (80 to 6400 cm for 38 kHz, 40 to 3200 cm for 75 kHz, 20 to 1600 cm for 150 kHz)
WVnnn	Broad Bandwidth Profiling Mode Ambiguity Velocity (0 to 390 cm/s)

NOTE. This table applies to the Ocean Surveyor firmware version 23.11.

Table 2: ADCP Factory Defaults

COMMAND	38.8 kHz	75 kHz	150 kHz
BAnnn	30	30	30
BCnnn	220	220	220
BEnnnn	1000	1000	1000
BPnnn	1	1	1
BXnnnn	20000	10000	05000
CBabc	411	411	411
CFabcde	11110	11110	11110
CXn,n	0,0	0,0	0,0
EA±nnnnn	0	0	0
ECnnnn	1500	1500	1500
EDnnnnn	0	0	0
EEnnnnnn	111111	111111	111111
EF±nn	1	1	1
EH±xxxx,y	0,0 (Stationary) 0,1 (Vessel)	0,0 (Stationary) 0,1 (Vessel)	0,0 (Stationary) 0,1 (Vessel)
EI±nnnnn	0	0	0
EJ±nnnnn	0	0	0
EP±xxxx, ±nnnn,z	0,0,0 (Stationary) 0,0,1 (Vessel)	0,0,0 (Stationary) 0,0,1 (Vessel)	0,0,0 (Stationary) 0,0,1 (Vessel)
ESnn	35	35	35
ET±nnnn	2100	2100	2100
EUn	0	0	0
EV±nnnnn	0	0	0
EXnnnnn	00000	00000	00000
EZnnnnnnn	1011101	1011101	1011101
NAnnn	255	255	255
NDnnnnnnnnn	111110000	111110000	111110000
NEnnnn	1000	1000	1000
NFnnnn	1600	800	400
NNnnn	050	050	050
NPnnn	000	000	000
NSnnnn	3200	1600	800
PDn	0	0	0
TEhhmmssff	00000000	00000000	00000000
TPmmssff	000300	000200	000100
WAnnn	255	255	255
WCnnn	120	120	120
WDnnn nnn nnn	111 110 000	111 110 000	111 110 000
WEnnnn	1000	1000	1000
WFnnnn [min]	1600	800	400
WNnnn	128	128	128
WPnnn	1	1	1
WSnnnn	3200	1600	800
WVnnnn	390	390	390

NOTE. This table applies to the Ocean Surveyor firmware version 23.11.

3.2 Command Descriptions

This section lists all ADCP commands. Each listing includes the command's purpose, format, range, and description. When appropriate, we include amplifying notes and examples. If a numeric value follows the command, the ADCP uses it to set a processing value (time, range, percentage, processing flags). All measurement values are in metric units (mm, cm, dm).

? - Help Menus

Purpose	:	Lists the major help groups.
Format	:	See description
Description	:	Entering ? by itself displays the command groups (deploy and System). To display help for one command group, enter *x*?, where *x* is the command group you wish to view. When the ADCP displays the help for a command group, it also shows the format and present setting of those commands. To see the help or setting for one command, enter the command name followed by a question mark. For example, to view the WP-command setting enter WP?.
Examples	:	See below.

```
>?
Available Commands:

@ ------------------------------ Special Commands
& ------------------------------ Engineering Test Commands
# ------------------------------ Expert Commands
B ------------------------------ Bottom Track Commands
C ------------------------------ Control Commands
E ------------------------------ Environment Commands
L ------------------------------ Fault Log Commands
N ------------------------------ Narrow Band Mode Commands
P ------------------------------ Performance Test Commands
T ------------------------------ Time Commands
V ------------------------------ Display Banner
W ------------------------------ Water Profiling Commands
? ------------------------------ Display Main Menu
```

NOTE. The Special @, &, and # commands are for RDI use only and are not documented in this book.

Break

Purpose : Interrupts the ADCP without erasing present settings.

Format : <BREAK>

Description : A BREAK signal interrupts ADCP processing. It is falling-edge triggered and the transition must last at least 300 ms. A BREAK initializes the system, returns a wake-up (copyright) message, and places the ADCP in the DATA I/O mode. The BREAK command does not erase any settings or data. Using *BBTalk*, pressing the **End** key sends a BREAK.

Example : <BREAK>

```
Ocean Surveyor Broadband/Narrowband ADCP
RD Instruments (c) 1997-2000
All rights reserved
Firmware Version 23.xx
>
```

V - Display Banner

Purpose : Displays the (wakeup message)

Format : V

Description : Only displays the banner message. This command does not wakeup the ADCP.

Example : See below.

```
>v
Ocean Surveyor Broadband/Narrowband ADCP
RD Instruments (c) 1997-2000
All rights reserved.
Firmware Version: 23.xx
```

3.3 Bottom-Track Commands

The Ocean Surveyor uses these commands for bottom-tracking applications. Bottom-track (BT) commands tell the ADCP to collect speed-over-bottom data and detected range-to-bottom data. Bottom Tracking is ON (BP1) by default. Sending a zero BP-command (BP0) turns off the bottom-tracking process.

BA - Amplitude Threshold

Purpose	:	Sets the minimum value for a valid bottom detection.
Format	:	BA*nnn*
Range	:	*nnn* = 1 to 255 counts
Default	:	BA030
Description	:	BA sets the minimum amplitude of an internal bottom-track filter that determines bottom detection. Reducing BA increases the bottom-track detection range, but also may increase the possibility of false bottom detections.

NOTE. The default setting for this command is recommended for most applications.

BC - Correlation Threshold

Purpose	:	Sets minimum correlation magnitude for valid velocity data.
Format	:	BC*nnn*
Range	:	*nnn* = 0 to 255 counts
Default	:	BC220
Description	:	Sets a minimum threshold for good bottom-track data. The ADCP flags as bad any bottom-track data with a correlation magnitude less than this value.
Note	:	A count value of 255 is a perfect correlation (i.e. a solid target).

NOTE. The default setting for this command is recommended for most applications.

BE - Error Velocity Threshold

Purpose	:	Sets maximum error velocity for good bottom-track water-current data.
Format	:	BE*n*
Range	:	*n* = 0 to 9999 mm/s
Default	:	BE1000
Description	:	The ADCP uses this parameter to determine good bottom-track velocity data. If the error velocity is greater than this value, the ADCP marks as bad all four beam velocities (or all four coordinate velocities, if transformed). If three beam solutions are allowed (see EX-command) and only three beams are good, then the data is accepted since four good beams are needed for error velocity calculation.

CAUTION. The default setting is set purposely high. We recommend extreme caution and testing before changing this setting. **Data rejected by this command is lost and cannot be regained.**

BP - Bottom-Track Pings

Purpose	:	Sets the number of bottom-track pings to average together in each data ensemble.
Format	:	BP*n*
Range	:	*n* = 0 to 999 pings
Default	:	BP1
Description	:	BP sets the number of bottom-track pings to average together in each ensemble before sending/recording bottom-track data.
Notes	:	1. The ADCP interleaves bottom-track pings with water-track pings (see TP-command) with the bottom track ping being the first ping in an ensemble. 2. If BP = zero, the ADCP does not collect bottom-track data.

BX - Maximum Tracking Depth

Purpose	:	Sets the maximum tracking depth in bottom-track mode.
Format	:	BX*nnnn*
Range	:	*nnnn* = 0 to 99999 decimeters (meters x 10)
Default	:	BX20000 (38 kHz), BX10000 (75 kHz), BX05000 (150 kHz)
Description	:	BX sets the maximum tracking depth used by the ADCP during bottom tracking. This prevents the ADCP from searching too long, and too deep for the bottom, allowing a faster ping rate when the ADCP loses track of the bottom.
Example	:	If you know the maximum depth in the deployment area is 500 meters (5000 decimeters), set BX to a value slightly larger than 5000 dm, say 5250 dm, instead of 9999 dm. Now if the ADCP loses track of the bottom, it will stop searching for the bottom at 5250 dm (525 m) rather than spend time searching down to 9999 dm (999.9 m).

3.4 Control System Commands

The Ocean Surveyor uses the following commands to control certain system parameters.

CB - Serial Port Control

Purpose : Sets the RS-232/422 serial port communications parameters (Baud Rate/Parity/Stop Bits).

Format : CB*abc*

Range : *a* = baud rate, *b* = parity, *c* = stop bits (see description)

Default : CB411

Description : The ADCP and your external device (dumb terminal, computer software) MUST use the same communication parameters to *talk* to each other. After you enter valid CB parameters, the ADCP responds with a ">" prompt. You may now change the external device's communication parameters to match the ADCP parameters before sending another command.

Table 3: Serial Port Control

Baud Rate	Parity	Stop Bits
0 = Default (9600)	0 = Default (None)	0 = Default (1 Bit)
1 = 1200	1 = None	1 = 1 Bit
2 = 2400	2 = Even	2 = 2 Bits
3 = 4800	3 = Odd	
4 = 9600	4 = High	
5 = 19200	5 = Low	
6 = 38400		
7 = 57600		
8 = 115200		

Setting the Baud Rate in the ADCP. The ADCP can be set to communicate at baud rates from 1200 to 115200. The factory default baud rate is always 9600 baud. The baud rate is controlled via the CB-command. The following procedure explains how to set the baud rate and save it in the ADCP. This procedure assumes that you will be using the program *BBTalk* that is supplied by RD Instruments.

a. Connect the ADCP to the computer and apply power (see the Read This First book).

b. Start the *BBTalk* program and wakeup the ADCP by sending a break signal with the **End** key.

c. Send the command CR1 to place the ADCP in the factory default setup.

d. Send the CB-command that selects the baud rate you wish. The following are the typical CB-command settings for different baud rates with no parity and 1 stop bit:

Table 4: Baud Rate

Baud Rate	CB-Command
1200	CB111
2400	CB211
4800	CB311
9600	CB411 (Default)
19200	CB511
38400	CB611
57600	CB711
115200	CB811

e. On the **File** menu, click **Options** to open the *BBTalk* communication port setup window. Change the communication port settings to match your new CB command setting.

f. Press **OK** to exit the communication port setup window. The ADCP is now set for the new baud rate. The baud rate will stay at this setting until you send a <break>. To permanently save the new baud rate, send the CK command (see "CK - Keep Parameters," page 13). The baud rate will stay at this setting until you send a CR1 command (return to factory defaults).

CF - Flow Control

Purpose : Sets various ADCP data flow-control parameters.

Format : CF*abcde*

Range : *a* = ensemble cycling, *b* = ping cycling, *c*= binary/ASCII, *d* = serial port, *e* = not used

Default : 11110

Description : CF defines whether the ADCP: generates data ensembles automatically or manually; generates pings immediately or manually; sends serial output data in binary or Hex-ASCII format; sends or does not send output data to the serial interface.

Table 5: Flow Control

Command	Description
CF1xxxx	Automatic Ensemble Cycling – Automatically starts the next data collection cycle after the current cycle is completed. Only a <BREAK> can stop this cycling.
CF0xxxx	Manual Ensemble Cycling – Enters the STANDBY mode after transmission of the data ensemble, displays the “>” prompt, and waits for a new command.
CFx1xxx	Automatic Ping Cycling – Pings immediately when ready.
CFx0xxx	Manual Ping Cycling – Sends a “<” character to signal ready to ping, and then waits to receive an <Enter> before pinging. The <Enter> sent to the ADCP is not echoed. This feature lets you manually control ping timing within the ensemble.
CFxx1xx	Binary Data Output – Sends the ensemble in binary format, if serial output is enabled (see below).
CFxx0xx	Hex-ASCII Data Output – Sends the ensemble in readable hexadecimal-ASCII format, if serial output is enabled (see below).
CFxxx1x	Enable Serial Output – Sends the data ensemble out the RS-232/422 serial interface.
CFxxx0x	Disable Serial Output – No ensemble data are sent out the RS-232/422 interface.
CFxxxx1	Not used
CFxxxx0	Not used
Example	CF11110 (default) selects automatic ensemble cycling, automatic ping cycling, Binary data output, and enables serial output.

NOTE. The *VmDas* program sets the Ocean Surveyor to a manual ensemble mode (CF01110) so that it controls when the ensemble occurs.

CK - Keep Parameters

Purpose : Stores present parameters to non-volatile memory.

Format : CK

Description : CK saves the present user command parameters to non-volatile memory. The ADCP maintains data stored in the non-volatile memory (user settings) even if power is lost. You can recall parameters stored in non-volatile memory with the CR0-command. When CR0 is sent, the command set is restored to values previously saved to non-volatile memory.

CR - Retrieve Parameters

Purpose : Retrieves the command set from non-volatile memory or restores factory defaults.

Format : CR*n*

Range : *n* = 0 (User) to 1 (Factory Default)

Description : If *n* is zero, then the command set previously stored with the CK command (see "CK - Keep Parameters," page 13) is retrieved from non-volatile memory. If *n* is one, then the factory default commands are restored.

Note : CR keeps the present baud rate and does not change it to the value stored in non-volatile memory or ROM. This ensures the ADCP maintains communications with the computer.

CS - Start Pinging (Go)

Purpose : Starts the data collection cycle.

Format : CS

Description : The ADCP starts data collection. While collecting data, the ADCP will ignore further commands unless a <BREAK> is sent to interrupt data collection.

CX – Trigger Input/Output

Purpose : The Trigger Input allows the Ocean Surveyor to be pinged by an external +5V logic level signal.

Format : CX*a*,*b*

Range : *a* = 0 to 5

b = 0 to 5

Default : CX0,0

Descriptions : The minimum duration for the Trigger Input is 1 ms. The Input resistance is at least 2.7 kOhm. The Trigger Output is a +5V logic level signal as well. The nominal source resistance of the Trigger Output is 50 Ohms. The command that controls the Trigger Output and Input is CX*a*,*b*, where "*a*" controls the Trigger Input mode, and "*b*" the Trigger Output mode. For flexibility, several modes for the Trigger Input and Output operation have been implemented. See Table 6, page 15 for a description of the command.

Table 6: CX Command Description

Command	Action:	Description
CX 0,b	Trigger Input off	Normal Ocean Surveyor operating mode.
CX 1,b	Positive edge Trigger Input	Used if the Ocean Surveyor is to be Triggered by other equipment. One ping is executed on every rising edge of the Trigger signal. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%.
CX 2,b	Negative edge Trigger Input	Used if the Ocean Surveyor is to be Triggered by other equipment. One ping is executed on every falling edge of the Trigger signal. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%.
CX 3,b	Any edge Trigger Input	Used if the Ocean Surveyor is to be Triggered by other equipment. One ping is executed on every rising and falling edge of the Trigger signal. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%.
CX 4,b	High level Trigger Input	Used if the Ocean Surveyor is to be Triggered by other equipment. The Ocean Surveyor transmits pings as long as the positive level of the Trigger signal is present. In this way, a single ping or multiple pings can be transmitted depending on the duration of the positive level. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%. A time between pings has to be set for cases where multiple pings should be transmitted.
CX 5,b	Low level Trigger Input	Same as CX4,b except the Trigger is active at the low-level of the Trigger signal. Care has to be taken by the user not to exceed the maximum allowable transmit duty cycle of 15%. A time between pings has to be set for cases where multiple pings should be transmitted.
CX a,0	Trigger Output off	Normal Ocean Surveyor operating mode.
CX a,1	Trigger Output – XMT	The Trigger Output is at a high level during the time the Ocean Surveyor transmits.
CX a,2	Trigger Output – RCV	The Trigger Output is at a high level during the time the Ocean Surveyor receives.
CX a,3	Trigger Output – X/R	The Trigger Output is at a high level during the time the Ocean Surveyor transmits and receives.
CX a,4	Trigger Output – inverted X/R Trigger	Identical to CXa,3, except the signal is inverted. The Trigger Output is at a high level while the OS is not transmitting or receiving.

3.5 Environmental Commands

The ADCP uses the following commands to control the environmental and positional information that affects internal data processing.

EA - Heading Alignment

Purpose : Corrects for physical heading-like misalignment between the projection of Beam 3 onto the ship's forward-starboard plane and the ship's forward axis.

Format : EA±*nnnnn*

Range : ±*nnnnn* = -179.99 to 180.00 degrees

Default : EA0

Description : EA is a heading-like alignment angle between the projection of the Y axis and the forward axis of the ship used in heading output and for transformation to earth coordinates. EA is a rotation about the mast (M) axis of the ship. It is defined as the heading of the Y instrument axis when the ship is level with ship heading zero. The Y instrument axis is the projection of beam 3 onto the instrument's X-Y plane. Use the EV-command to correct for heading bias (e.g., synchro/stepper signal bias, magnetic variation).

For systems that are fixed in place on a moving vessel and that have an external heading source or an internal heading source, use EA to set the amount of rotation that the Y axis is physically offset from the vessel's centerline (see Figure 1, page 17). For systems that are stationary and have an internal compass that are not on a moving platform, EA is typically set to zero, unless ship attitude output data is desired for other purposes (see the EE command).

NOTE. See the Installation Guide for a description of methods to calibrate EA after installation of an obliquely mounted ADCP (EI and EJ not zero).

Example : The ADCP is mounted in place on a moving ship. The Y-axis has been rotated 45 clockwise (+45) from the ship's centerline. Use the EA command to tell the ADCP where the Y-axis is in relation to the ship's centerline. To convert +45 to an EA-command value, multiply the desired alignment angle in degrees by 100:

```
EA = +45.00 × 100 = +4500 = EA+04500
```

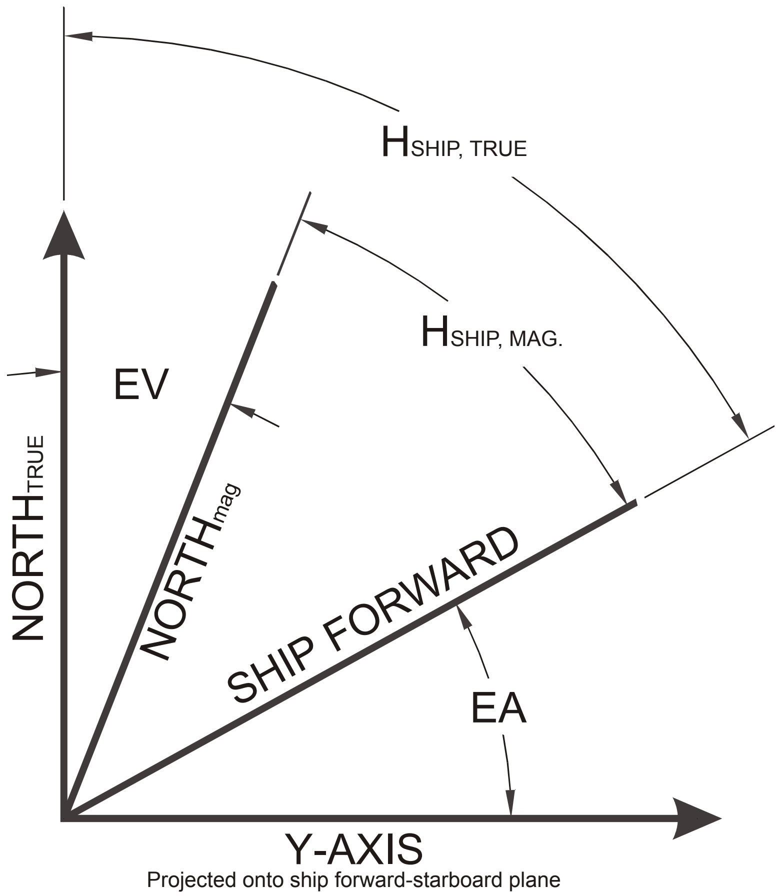


Figure 1. Y-axis Alignment

NOTE. This view shows positive values for EV and EA.

NOTE. If you are using the *VmDas* software, then this setting is performed in the same fashion from the **Transforms** tab. See the *VmDas* User's Guide for details.

EC - Speed of Sound

Purpose : Sets the speed of sound value used for ADCP data processing.

Format : EC*nnnn*

Range : *nnnn* = 1400 to 1600 meters per second

Default : EC1500

Description : EC sets the sound speed value used by the Ocean Surveyor ADCP to scale depth cell size, and range to the bottom. The ADCP assumes the speed of sound reading is taken at the transducer head. See the primer for information on speed of sound calculations.

Note : If the EZ *Speed of Sound* field = 1, the ADCP overrides the manually-set EC value and calculates speed of sound using the values determined by transducer depth (ED), salinity (ES), and transducer temperature (ET). EZ also selects the source for ED, ES, and ET.

ED - Depth of Transducer

Purpose : Sets the ADCP transducer depth.

Format : ED*nnnnn*

Range : *nnnnn* = 0 to 65535 decimeters (meters × 10)

Default : ED00000

Description : ED sets the ADCP transducer depth. This measurement is taken from sea level to the transducer faces. The ADCP uses ED in its speed of sound calculations. The ADCP assumes the speed of sound reading is taken at the transducer head. See the primer for information on speed of sound calculations.

Note : If the EZ *Transducer Depth* field = 1, the ADCP overrides the manually set ED value and uses depth from the depth sensor. If a depth sensor is not available, the ADCP uses the manual ED setting.

EE - Attitude Data Output and Interpolation

Purpose	:	Specifies the coordinate frame used to reference the specialized attitude data types of Table 7.
Format	:	EE *abcdef*
Range	:	Firmware switches (see description)
Default	:	EE111111

> **NOTE.** The default setting for this command is recommended for most applications.

Description : Bits "a" and "b" are firmware switches that tell the ADCP what coordinate frame will be used to reference the heading, pitch and roll in the specialized attitude data type of Table 7.

Depending on the EE command bits "c" and "d" (see below), the attitude data will either be the pre-ping sample, an interpolation to the center of the profile for water track, an interpolation to the middle of the bottom echo or water mass layer. The attitude data at these times in addition to the attitude rates will be output for each of the selected ping types (bottom track, water mass or water profile) and in the specified coordinate system(s) if either of the first two EE bits is set.

The coordinate frames specified by bits "a" and "b" are as follows:

Table 7: Coordinate Frame

Ab	Coordinate Frame
00	No specialized attitude data type output
01	Instrument referenced data will be output
10	Ship referenced data will be output
11	Both ship and instrument referenced data will be output

Bits "c" and "d" control the interpolation of attitude information that is used for earth velocity transformations. These bits have the following meaning:

Field	Value	Description
Water Profile		
c	0	Use pre-ping attitude sample only for water ping. Apply the same transformation to all bins. Similar to early RDI firmware. The attitude data output by bits "a" and "b" will be the pre-ping sample.
c	1	Use a single interpolated attitude value based on pre and post ping sample corresponding to half the length of the profile for water profiling. The attitude data output by bits "a" and "b" will be this interpolated value.
c	2	Interpolate attitude across each bin of the profile using the pre and post ping samples of attitude. The attitude data output by bits a and b will be the value corresponding to the first bin of the profile. For the case of an even number of bins, the lower bin will be used.
Bottom Track or Water Mass		
d	0	Use pre-ping attitude sample only for each bottom and/or water mass ping. Similar to early RDI firmware.
d	1	Use a single interpolated attitude value based on pre and post ping sample corresponding to the time when the transmit pulse is halfway across the bottom and/or water mass layer for bottom track and water mass layers, respectively.

Bit "e" controls the output of Attitude Command Parameters. Bit e = 1 causes this data type to be output. See "Binary Fixed Attitude Data Format," page 69 for a description of this data type.

Bit "f" controls the type of beam velocity data. Setting bit "f" set to 1 results in nominal 30° beam coordinate velocities output in the ensemble (later firmware will have the correction for autocorrelation peak movement and beam angle change with temperature). Setting Bit "f" to 0 results in raw beam velocities output in the ensemble.

EF - External Pitch/Roll Factor

Purpose : Applies an integer factor to pitch and roll inputs.

Format : EF±*nn*

Range : *n* = -99 to 99

Default : EF1

Description : The EF command applies an integer divisor or a multiplier to pitch and roll inputs received from an external synchro (e.g., EZxxx22xxx). For positive EF command inputs, a divisor is applied. For negative EF command inputs, a multiplier is applied. The range of divisors or multipliers is 1 to 99. When the EF-command is set to zero it forces pitch and roll to zero.

> **NOTE.** The default setting for this command is recommended for most applications.

EH - Heading Angle

Purpose : Sets the ADCP heading and the coordinate frame (instrument or ship) to which EH-command input refers.

Format : EH±*xxxx, y*

Range : ±*xxxx* = -179.99 to +180.00 degrees

y = 0 for instrument coordinates

y = 1 for ship coordinates

Default : EH0,0 (Stationary systems), EH0,1 (Vessel)

Description : EH sets the ADCP heading and heading coordinate frame if both arguments are entered.

EH sets the ADCP heading if only one argument is entered. This heading value is assumed to be in instrument coordinates.

Figure 2, page 28 shows transducer beam axes and tilt signs.

EH may be entered after the unit is commanded to ping (CS command) and will be used in subsequent pings.

Example : Convert pitch and roll values of +14 degrees and -3.5 degrees to EP-command values referenced to ship coordinates.

```
Pitch in hundredths = 14.00 × 100 = 1400
Roll in hundreths = -3.50 × 100 = -350
EP 1400, -350, 1            (+ in front of 1400 is optional)
```

Note : If the EZ *Roll and Pitch* fields = 1, the ADCP overrides the manually-set EP value and uses roll from the transducer's internal tilt sensor. If the EZ *Roll and Pitch* fields = two the ADCP takes roll from an external synchro. If EZ *Roll and Pitch* fields are zero the ADCP uses the manual EP command settings.

See the EZ command for more details and on restrictions for the case of mixed pitch and roll sources.

EI - Roll Misalignment Angle

Purpose	:	Corrects for a physical roll-like misalignment between the x-axis of the instrument and the ship's starboard axis.
Format	:	EI±*nnnnn*
Range	:	±*nnnnn* = -179.99 to 180.00 degrees
Default	:	EI0
Description	:	EI is a rotation about the ship's forward axis. It is defined as the roll of the ship when the instrument is level.

For systems that are fixed in place on a moving vessel and that have an external roll source or an internal roll source, use EI to set the amount of rotation that the instrument's x-axis is physically offset from the ship's starboard axis. Note that EI command can also be used to align an upward pointing unit (e.g., mounted on a submarine) to the ship's axis.

For systems that are stationary and have an internal compass, EI is typically set to zero since the velocity data is referenced to either beam, instrument or geographic coordinates instead of ship coordinates. However, a non-zero value may be used if ship attitude output data is desired for other purposes (see the EE command).

NOTE. See the Installation Guide for a description of methods to calibrate EI after installation of the ADCP.

EJ - Pitch Misalignment Angle

Purpose	:	Corrects for a physical pitch-like misalignment between the y-axis of the instrument and the ship's forward axis.
Format	:	EJ±*nnnnn*
Range	:	±*nnnnn* = -179.99 to 180.00 degrees
Default	:	EJ0
Description	:	EJ is a rotation about the ship's starboard axis. It is defined as the roll of the ship when the instrument is level.

For systems that are fixed in place on a moving vessel and that have an external pitch source or an internal pitch source, use EJ to set the amount of rotation that the instrument's y-axis is physically offset from the ship's forward axis.

For systems that are stationary and have an internal compass, EJ is typically set to zero since the velocity data is referenced to either beam, instrument or geographic coordinates instead of ship coordinates. However, a non-zero value may be used if ship attitude output data is desired for other purposes (see the EE command).

> **NOTE.** See the Installation Guide for a description of methods to calibrate EJ after installation of the ADCP.

EP - Pitch and Roll Angles

Purpose : Sets the ADCP pitch (tilt 1) and, optionally, the roll (tilt 2) and the coordinate frame (instrument or ship) to which EP-command pitch and roll inputs refer. Alternatively, the EP commands may be used with single arguments, in which case it is assumed that the pitch and roll inputs represent the pitch and roll of the instrument rather than those of the ship.

Format : EP±*xxxx*, ±*yyyy*, *z*

Range : ±*xxxx and* ±*yyyy* = -179.99 to +180.00 degrees
z = 0 for instrument coordinates,
z = 1 for ship coordinates

Default : EP0,0,0 (Stationary), EP0,0,1 (Vessel)

Description : EP sets the ADCP pitch (tilt 1) and roll (tilt 2) and the pitch/roll coordinate frame if all three arguments are entered.

EP sets the ADCP pitch (tilt 1) if only one argument is entered. This pitch value is assumed to be in instrument coordinates.

If only two fields are entered, a command entry error is issued.

Figure 2, page 28 shows transducer beam axes and tilt signs.

EP may be entered after the unit is commanded to ping (CS command) and will be used in subsequent pings.

Example : Convert pitch and roll values of +14 degrees and -3.5 degrees to EP-command values referenced to ship coordinates.

```
Pitch in hundredths = 14.00 × 100 = 1400
Roll in hundredths = -3.50 × 100 = -350

EP 1400, -350, 1           (+ in front of 1400 is optional)
```

Note : If the EZ *Roll and Pitch* fields = 1, the ADCP overrides the manually-set EP value and uses roll from the transducer's internal tilt sensor. If the EZ *Roll and Pitch* fields = 2, the ADCP takes roll from an external synchro. If EZ *Roll and Pitch* fields are 0, the ADCP uses the manual EP command settings.

See the EZ command for more details and on restrictions for the case of mixed pitch and roll sources.

ES - Salinity

Purpose : Sets the water's salinity value.

Format : ES*nn*

Range : *nn* = 0 to 40 parts per thousand

Default : ES35

Description : ES sets the water's salinity value. The ADCP uses ES in its speed of sound calculations. The ADCP assumes the speed of sound reading is taken at the transducer head.

ET - Temperature

Purpose : Sets the water's temperature value.

Format : ET±*nnnn*

Range : ±*nnnn* = -5.00 C to +40.00 C

Default : ET2100

Description : ET sets the water's temperature value. The ADCP uses ET in its speed of sound calculations (see the primer). The ADCP assumes the speed of sound reading is taken at the transducer head.

Example : Convert temperatures of +14 C and -3.5 C to ET-command values.

```
ET = 14.00 × 100 = 1400 = ET1400 (+ is understood)
ET = -3.50 × 100 = -350 = ET-0350
```

Note : If the EZ *Temperature* field = 1, the ADCP overrides the manually-set ET value and uses temperature from the transducer's temperature sensor. If neither sensor is available, the ADCP uses the manual ET setting.

EU - Up/Down Orientation

Purpose : Sets the ADCP up/down orientation.

Format : EU*n*

Range : *n* = 0 or 1 (0 = down, 1 = up)

Default : EU0

Description : In conjunction with the EZ command, EU is used to manually specify the orientation of the ADCP.

EV - Heading Bias

Purpose : Corrects for electrical/magnetic bias between the ADCP heading value and the heading reference.

Format : EV±*nnnnn*

Range : ±*nnnnn* = -179.99 to 180.00 degrees

Default : EV0

Description : EV is the heading angle that counteracts the electrical bias or magnetic variation (declination) between the ADCP and the heading source. Use the EA-command to correct for physical heading misalignment between the ADCP and a vessel's centerline.

For systems that are fixed in place on a moving vessel and that have an external heading source, use EV to set the amount of electrical bias between the vessel's heading source reading and the ADCP's output heading value. The EV command is usually required only when using an external gyrocompass that has a stepper output voltage or that has a non 1:1 turns ratio. If the gyrocompass has a 1:1 turns ratio, EV is usually set to zero.

For systems that are stationary and have an internal compass, use EV to counteract the effects of magnetic variation at the deployment site.

For many synchro systems, an independent method is available to dial in a heading offset from the front panel of the VM chassis, so that the EV command is not needed for this purpose.

Examples : 1. A vessel-mounted ADCP is receiving heading from an external gyrocompass that has a 360:1 turns ratio. When you initialize the system, the ADCP heading output constantly reads 10 degrees higher (+10 degrees) than the gyro’s value. To counteract this electrical bias caused by incorrect synchronization, you must enter a heading bias value of -10. To convert -10 to an EV-command value, multiply the desired bias angle in degrees by 100: EV = -10.00 × 100 = -1000 = EV-1000.

2. A bottom-mounted ADCP is receiving heading from its internal compass. A magnetic variation chart for the deployment area shows a variation of W3.5 (-3.5). To counteract the effects of this magnetic field, you must enter a heading bias value of -3.5. To convert -3.5 to an EV-command value, multiply the desired bias angle in degrees by 100: EV = -3.5 × 100 = -350 = EV-350.

NOTE. In firmware version 14.09 and lower, the EB command was used in place of the EV command. If you are using command files created for these firmware versions, make sure you change the EB command to the new EV command.

If you are using the *VmDas* software, then this setting is performed in the same fashion from the **Transforms** tab. See the *VmDas* User's Guide for details.

EX - Coordinate Transformation

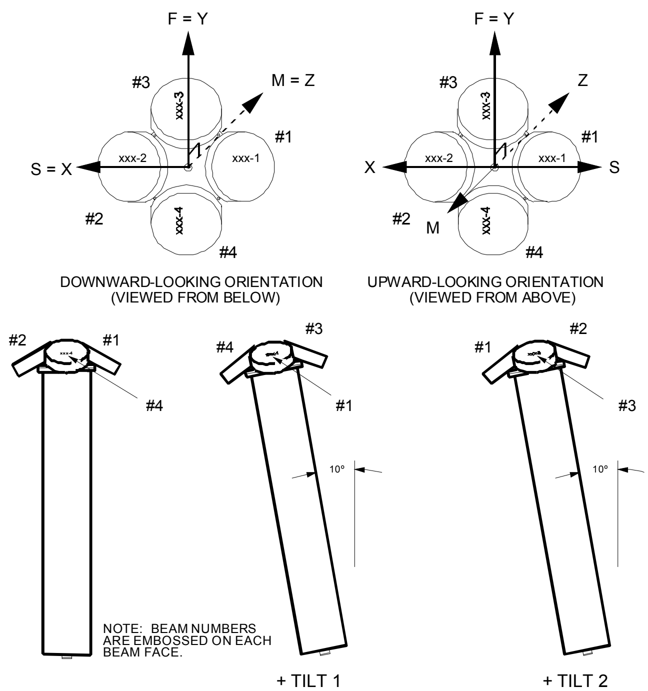
Purpose	:	Sets the coordinate transformation processing flags.
Format	:	EX*nnnnn*
Range	:	Firmware switches (see Table 8)
Default	:	EX00000
Description	:	EX sets firmware switches that control the coordinate transformation processing for velocity (see "Binary Velocity Data Format," page 61)and percent-good output data.

Table 8: Coordinate Transformation Processing Flags

Bit Number	**Description**
EX00xxx	No transformation. Radial beam coordinates, i.e., 1, 2, 3, 4. Heading/Pitch/Roll not applied.
EX01xxx	Instrument coordinates. X, Y, Z components relative to the ADCP. Heading/Pitch/Roll not applied.
EX100xx	Unleveled Ship coordinates (Note 1) S, F, M components relative to the ship. Heading, pitch and roll not applied. EA, EI and EJ commands affect velocity rotations.
EX101xx	Leveled Ship coordinates (Note 1) S, F, M components relative to the projected ship's forward axis and the earth's horizontal plane. Heading not applied. Pitch and roll applied. The EA command always affects velocity rotations. The EI and EJ commands affect velocity rotations if either external pitch/roll sensors or external heading sensor is selected with the EZ or EP command.
EX110xx	Unleveled Earth coordinates (Note 1). Heading applied, but pitch and roll assumed zero for the raw sensor data, no matter whether referring to ship or instrument axes as selected by the EZ and EP command. The EA , EI and EJ commands always affects velocity rotations if either external sensors are selected with the EZ, EP or EH command.
EX111xx	Earth coordinates (Note 1) East, North, Vertical components relative to Earth East, North and Up components. Heading, pitch and roll applied for velocity rotations. EA, EI and EJ commands affect velocity rotations if external sensors are selected by the EZ, EP or EH command. Sometimes called geographic coordinates.
Exxx1xx	Use tilts (pitch and roll) in transformation
Exxxx1x	Allows 3-beam solutions if one beam is below the correlation threshold set by WC
Exxxxx1	Allow bin mapping (only performed for leveled ship and leveled earth transformations).

Notes : 1. For ship and earth-coordinate transformations to work properly, you must set Heading, Pitch and Roll alignment (EA, EI and EJ) and Heading Bias (EV) correctly. You also must ensure that the tilt and heading sensors are active (EZ).

NOTE. *VmDas* set the Ocean Surveyor ADCP to beam coordinates (EX00000).



SIGN OF ANGLE FOR A UNIT FACING	UP	DOWN
TILT 1 (PITCH) BEAM #3 HIGHER THAN BEAM #4	+	+
TILT 2 (ROLL) BEAM #2 HIGHER THAN BEAM #1	+	-

Figure 2. ADCP Coordinate Transformation

NOTE. Depicted alignment of the ship and instrument axes is for the case EA0, EJ0. Up/Down orientation is specified by the EI, EU and EZ commands.

Downward:

a. EI0 when either up/down sensor indicates downward orientation

b. EU and EZ commands specify a downward looking instrument.

Upward:

a. EI180 when either up/down sensor indicates downward orientation

b. EU and EZ commands specify an upward looking instrument.

EZ - Sensor Source

Purpose : Selects the source of environmental sensor data.

Format : EZ*cdhprstu*

Range : Firmware switches (see description)

Default : EZ10111010

Description : Setting the EZ-command firmware switches tells the ADCP to use data from a manual setting or from an associated sensor. When a switch value is nonzero, the ADCP overrides the manual E-command setting and uses data from the appropriate sensor. If no sensor is available, the ADCP defaults to the manual E-command setting in instrument coordinates regardless of the coordinate frame parameter of the E-command setting.

Refer to Figure 3, page 31 for a description of how the EV and EA commands are used for internal and external heading sensors.

The following table shows how to interpret the sensor source switch settings.

Table 9: Sensor Source Switch Settings

FIELD		VALUE = 0	VALUE = 1	VALUE = 2
C	Speed of sound	Manual EC	Calculates using ED, ES, ET	Not Allowed
D	Depth	Manual ED	Not Allowed	Not Allowed
H	Heading	Manual EH	Internal transducer sensor	External synchro/Stepper Gyro
P	Pitch (tilt 1)	Manual EP	Internal transducer sensor	External synchro Gyro
R	Roll (tilt 2)	Manual ER	Internal transducer sensor	External synchro Gyro
S	Salinity	Manual ES	Not Allowed	Not Allowed
T	Temperature	Manual ET	Internal transducer sensor	Not Allowed
U	Up/Down Orientation	Manual EU	Not Allowed	Not Allowed

Example : EZ10122010 means calculate speed of sound from readings, use manual depth, transducer heading, external tilt sensors, manual salinity, transducer temperature, manual up/down orientation.

Note : When you send a PS1-command, the displayed Fixed Leader data shows the available sensors connected to the ADCP. To interpret this PS1 field, convert the value to binary. Although you can enter a “2” (for external synchro) as part of the EZ-command string, the ADCP only displays zeroes and ones (0 = manual, 1 = either internal or external sensor) (see "Binary Fixed Leader Data Format," page 53).

If EZ pitch is one (internal sensor), a pendulum pitch correction will be applied that removes the effect of roll on pitch. This effect is common to most tilt sensors (electrolytic tilt and pendulum).

The Pitch and Roll bits "p" and "r" must both reference the same coordinate system. The following table summarizes the valid EZ and EP inputs.

EZpr	EP Coordinate Frame	Comment
00	Ship or Instrument (EP X,X,X)	Allowed
01	Instrument (EP X,X,0)	Allowed
02	Ship (EP X,X,1)	Allowed
10	Instrument (EP X,X,0)	Allowed
10	Ship (EP X,X,1)	Not Allowed
11	Not Applicable	Allowed
12	Not Applicable	Not Allowed
20	Ship (EP X,X,1)	Allowed
20	Instrument (EP X,X,0)	Not Allowed
21	Not Applicable	Not Allowed
22	Not Applicable	Allowed

Note : "X" in the above table is an arbitrary value.

When specifying hard-coded values (either EZpr bit 0), the EP command must be in the correct coordinate frame. To avoid conflicts when setting EZpr, these bits must set to non-zero values until the EP command has been entered with the coordinate frame that matches desired non-zero EZpr.

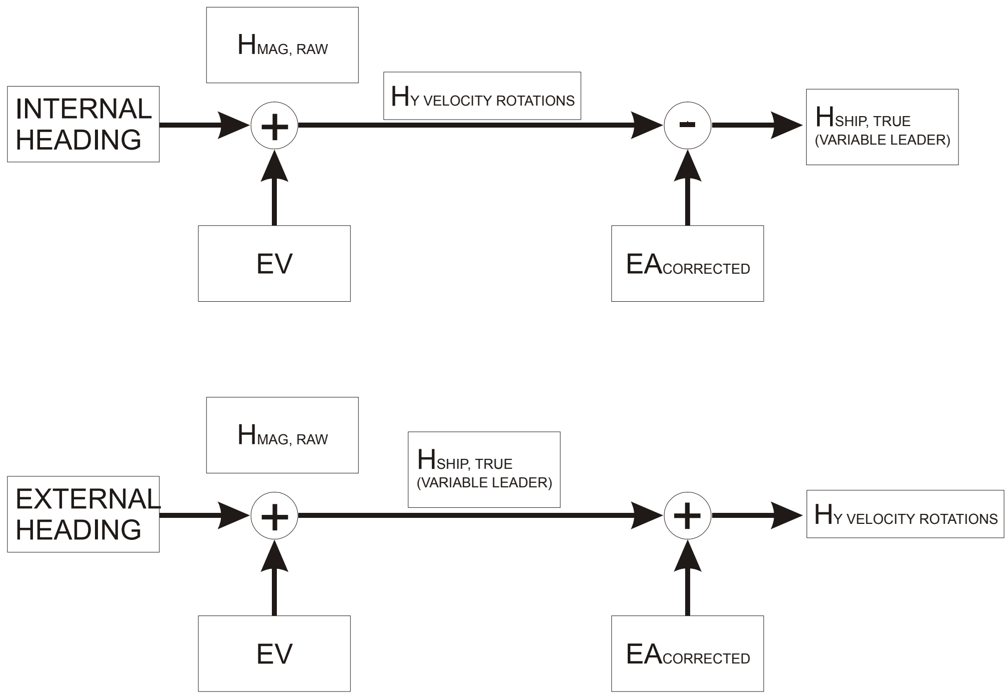


Figure 3. Heading Sensor Source and the Application of EV and EA.

3.6 Fault Log Commands

The Ocean Surveyor uses the following commands to aid in troubleshooting and testing.

LC - Clear Fault Log

Purpose : Clears the fault log.

Format : LC

Description : This commands removes all recorded faults from the fault log..

Recommend : Use as needed.

Example

```
>LC
>LD  No faults recorded.
```

LD - Display Fault Log

Purpose : Displays the fault log.

Format : LD

Description : This commands shows all faults recorded in the fault log. This may aid in troubleshooting.

Recommend : Use as needed.

Example

```
>LD
Time of first fault:    2000/05/02,13:09:50
Overflow count:              0

Fault Log:
     Code            Count            Time                 Parameter
202   RTC POWER          1       2000/05/02,13:09:50       08410003h

End of fault log.
```

LL - Display Fault List

Purpose	:	Lists possible faults.
Format	:	LL
Description	:	This commands lists all fault conditions that are checked for by the ADCP.
Recommend	:	Use as needed.

Example

```
>LL
Fault List:
Code    Fault
001     RESET
100     FPGA
201     RTC BATT LO
202     RTC POWER
203     RTC CAL
300     COM TIMEOUT
301     BUFFER OUT
400     RAM FAULT
401     ROM FAULT
402     MALLOC FAIL
500     GYRO COM
501     GYRO CKSUM
502     TCM2 COM
503     TCM2 CKSUM
504     TEMP INIT
505     TEMP READ
506     TEMP RANGE
600     SYS CONFIG
601     CMD PARAMS
602     COM PARAMS
```

3.7 Narrow Bandwidth Profiling Commands

The following commands define the criteria used to collect the Narrow Bandwidth water-profile data.

NA – Narrow Bandwidth Profiling False Target Threshold

Purpose	:	Sets a false target (fish) filter
Format	:	NA*n*
Range	:	*n* = 0 to 255 counts
Default	:	NA255
Description	:	The ADCP uses the NA-command to screen profile data for false targets (usually fish). NA sets the maximum difference between echo intensity readings among the four profiling beams. If the NA threshold value is exceeded, the ADCP rejects velocity data on a cell-by-cell basis for either the affected beam (fish detected in only one beam) or for the affected cell in all four beams (fish detected in more than one beam). This usually occurs when fish pass through one or more beams.
Notes	:	A NA value of 255 disables this feature. A typical setting is 55 to 75.

NOTE. The default setting for this command is recommended for most applications.

ND - Narrow Bandwidth Profiling Data Out

Purpose	:	Selects the type of data that is output by the ADCP
Format	:	ND *abc def ghi*
Range	:	*a* = 0 to 1 *d* = 0 to 1 *g* = 0 to 1 *b* = 0 to 1 *e* = 0 to 1 *h* = 0 to 1 *c* = 0 to 1 *f* = 0 to 1 *i* = 0 to 1
Default	:	ND111 110 000
Description	:	The ND selects the type of data that is output depending on the value in each field. Setting a bit to 1 enables the output while a 0 disables output. The fields listed below.

a = velocity	*d* = percent good	*g* = reserved
b = power	*e* = status	*h* = reserved
c = echo intensity	*f* = reserved	*i* = reserved

Notes	:	If NP = 0, then no narrowband profile data is output regardless of the ND setting.

NOTE. The default setting for this command is recommended for most applications.

NE - Narrow Bandwidth Profiling Error Velocity Threshold

Purpose : Sets the maximum error velocity for good profile data.

Format : NE*n*

Range : *n* = 0 to 9999 mm/s

Default : NE1000

Description : NE sets a threshold value used to flag water-current data as good or bad. If the ADCP's error velocity value exceeds this threshold, it flags data as bad for a given depth cell. The NE-command screens for error velocities in both beam and transformed-coordinate data.

CAUTION. The default setting is set purposely high. We recommend extreme caution and testing before changing this setting. **Data rejected by this command is lost and cannot be regained.**

NF - Narrow Bandwidth Profiling Blank after Transmit

Purpose : Moves the location of first depth cell away from the transducer head to allow the transmit circuits time to recover before the receive cycle begins.

Format : NF*n*

Range : *n* = 0 to 9999 cm

Default : NF1600 (38kHz), NF800 (75kHz), NF400 (150kHz)

Description : NF positions the start of the first depth cell at some vertical distance from the transducer head. This allows the ADCP transmit circuits time to recover before beginning the receive cycle. In effect, NF blanks out bad data close to the transducer head, thus creating a depth window that reduces unwanted data in the ensemble.

Notes : Small NF values may show ringing/recovery problems in the first depth cells that cannot be screened by the ADCP. We recommend you set NF to no less than the default value.

NOTE. The default setting for this command is recommended for most applications.

NN - Narrow Bandwidth Profiling Number of Profile Depth Cells

Purpose	:	Sets the number of depth cells collected in each profile.
Format	:	NN*nnn*
Range	:	*nnn* = 1 to 128 depth cells
Default	:	NN50
Description	:	NN Sets the number of depth cells over which the ADCP collects data. The range of the profile is set by the number of depth cells (NN) times the size of each depth cell (NS).

NP - Narrow Bandwidth Profiling Pings Per Ensemble

Purpose	:	Sets the number of narrowband profile pings to average together in each data ensemble.
Format	:	NP*nnn*
Range	:	*nnn* = 0 to 999 pings
Default	:	NP0
Description	:	NP sets the number of narrowband profile pings to average together in each ensemble before sending profile data.
Notes	:	The ADCP interleaves profile pings with bottom-track pings (see TP-command). If NP = zero, the ADCP does not collect narrowband profile data.

NOTE. When using *VmDas*, the typical setup will use single ping (NP1) when doing Narrow Bandwidth profiling.

NS - Narrow Bandwidth Profiling Depth Cell Size

Purpose	:	Selects the volume of water for one measurement cell.
Format	:	NS*n*
Range	:	*n* = 1600 to 6400 cm for 38kHz systems. *n* = 800 to 3200 cm for 75kHz systems. *n* = 400 to 1600 cm for 150kHz systems.
Default	:	NS3200 (38kHz), NS1600 (75kHz), NS800 (150kHz)
Description	:	NS Sets the size of depth cells over which the ADCP collects data. The range of the profile is set by the number of depth cells (NN) times the size of each depth cell (NS).

3.8 Performance and Testing Commands

The ADCP uses the following commands for calibration and testing.

PA - Built-In Tests

Purpose	:	Sends and displays the results of a series of ADCP system diagnostic tests.
Format	:	PA
Description	:	These diagnostic tests check the major ADCP modules and signal paths. We recommend you run this command before data collection.
Example	:	See below.

```
>PA
RAM test...........PASS
ROM test...........PASS
Receive test.......PASS
Bandwidth test.....PASS
>
```

PC - Show Sensor Data

Purpose	:	Displays output of various ADCP sensors.
Format	:	PC*nnn*
Range	:	*nnn* = 0 to 2
Description	:	PC0 displays the help menu. PC1 is reserved for RDI use. PC2 shows sensor data for heading, pitch, roll, and temperature.
Examples	:	See below.
Note	:	Heading display is raw data from sensor and does not use any heading corrections. Heading source will correspond to source selected by the EZ-command.

```
>PC0
0=Help;2=Show Sensors
>PC2
Heading     Pitch      Roll        Temperature
 (int)      (int)      (int)       cts    degs
 000.0      +00.0      +00.0       0FF6   -36.3
 000.0      +00.0      +00.0       0FF5   -36.2
 000.0      +00.0      +00.0       0FF5   -36.2
 000.0      +00.0      +00.0       0FF5   -36.2
>
```

PD - Data Stream Select

Purpose	:	Selects the type of ensemble output data structure.
Format	:	PD*n*
Range	:	*n* = 0
Description	:	The Ocean Surveyor currently supports only the PD0 output data structure.

PS - Display System Parameters

Purpose	:	Displays ADCP system configuration data.
Format	:	PS*n*
Range	:	*n* = 0 to 4
Description	:	See below.

PS0

PS0 displays system configuration info.

```
>PS0
       Frequency:  38400 HZ
   Configuration:  4 BEAM, JANUS
 Transducer Type:  ROUND 36x36
  Beamformer Rev:  A02 or later
      Beam Angle:  30 DEGREES
    Beam Pattern:  CONVEX
     Orientation:  DOWN
    CPU Firmware:  23.03
    FPGA Version:  XA
 Attitude Sensor:  SYNCHRO
```

PS1

PS1 displays the contents of the PD0 fixed leader (i.e., fixed system commands and hardware/firmware information) in Hex-ASCII or binary format with the Least Significant Byte (LSB) first. For example, a Hex-ASCII output may look like this:

```
>PS1
3300000E0449020000048001002003C80001001564000000000000000000005D1D06043603010100
00270000000000000000006003
>
```

PS2

PS2 displays the contents of the PD0 variable leader (i.e., variable system commands and sensor readings) in Hex-ASCII or binary format with the Least Significant Byte (LSB) first. For example, a Hex-ASCII output may look like this:

```
>PS2
3D8000000045020D12222808000000A60500007D0EE8FEA9002300C8FF0000000000000000000000
0000000000000000000000000000000000000000000724
>
```

PS3

PS3 is reserved for RDI use.

PS4

PS4 displays the ping sequence.

```
>PS4
Ping Sequence:  BW
>
```

PT - Diagnostic Tests

Purpose	:	Displays results of the ADCP system diagnostic tests.
Format	:	PT*nnn*
Range	:	*n* = 0 to 200
Description	:	See below

PT0 - Help

Displays the test menu (shown below). As implied by the NOTE, adding 100 to the test number repeats the test continually until the ADCP receives a <BREAK>. Sending PT200 runs all tests. PT300 runs all tests continually until the ADCP receives a <BREAK>.

```
>PT0
Built In Tests
----------------
 PT0 = Help
 PT1 = NA
 PT2 = NA
 PT3 = Receive Path Test
 PT4 = NA
 PT5 = NA
 PT6 = Receive Bandwidth Test
 PT7 = NA
 PT8 = NA
 PT9 = NA
NOTE: Add 100 for automatic test repeat
PT200 = All tests
```

PT3 - Receive Path Test

This test displays receive path characteristics.

```
>PT3
Correlation Magnitude:
      Lag    Bm1      Bm2      Bm3      Bm4
       0     1.00     1.00     1.00     1.00
       1     0.77     0.77     0.78     0.77
       2     0.34     0.34     0.35     0.32
       3     0.05     0.11     0.05     0.04
       4     0.09     0.16     0.09     0.10
       5     0.08     0.13     0.08     0.06
       6     0.03     0.09     0.02     0.02
       7     0.02     0.09     0.02     0.03

RSSI: 13 13 11 14

PASSED
>
```

NOTE. The PT3 Test is considered to have normal values if the correlation values at lag 5 and greater are less than 0.50.

PT5 – Electronics Wrap Test

This test sets up the ADCP in a test configuration in which the test output lines from the timing generator circuit are routed directly to the receiver circuit. The receiver then processes this signal. The test output signal sends a certain correlation pattern when processed.

NOTE. Place the transducer in water **before** running this test.

```
pt5

Correlation Data:                       Amplitude Data:
Bin  0:   74   74   74   74               2    1    4    3
Bin  1:    8    8    8    8             116   85   82   92
Bin  2:  246  246  246  246             116   86   82   92
Bin  3:  146  146  146  146             116   85   82   93
Bin  4:   27   27   27   27             116   86   82   93
Bin  5:  254  254  254  254             116   86   82   93
Bin  6:   91   91   91   91             116   85   82   93
Bin  7:  146  146  146  146             116   87   82   92
Bin  8:   98   98   98   98             116   86   82   92
Bin  9:  254  254  254  254             116   86   82   93
Bin 10:    8    8    8    8             116   86   83   93
Bin 11:  146  146  158  146

>
```

CAUTION. Do NOT ping the Ocean Surveyor with the transducer in air. The power assembly board will short, causing the electronics chassis to no longer communicate. The transducer is pinged by sending a CS or PT5 command or if *VmDas* is started for collecting data – either of these methods will cause damage if the transducer in air.

PT6 - Receive Bandwidth Test

This test measures the receive bandwidth of the system.

```
>PT6
Receive Bandwidth:
........................................
  Expected      Bm1    Bm2    Bm3    Bm4
  --------     -----  -----  -----  -----
   15500       14432  14498  15752  15406

PASSED

>
```

NOTE. The PT6 Test is considered to have normal values if the received bandwidth for each beam is within ± 20% of the expected bandwidth.

3.9 Timing Commands

The following commands let you set the timing of various profiling functions.

TC - System Timer Value

Purpose	:	Outputs the system timer raw value.
Format	:	TC
Description	:	For RDI use only.

TE - Time Per Ensemble

Purpose	:	Sets the minimum interval between data collection cycles (data ensembles).
Format	:	TE*hhmmssff*
Default	:	TE00:00:00.00
Range	:	*hh* = 00 to 23 hours *mm* = 00 to 59 minutes *ss* = 00 to 59 seconds *ff* = 00 to 99 hundredths of seconds
Description	:	During the ensemble interval set by TE, the ADCP transmits the number of pings set by the WP, NP, and BP commands. If TE = 0, the ADCP starts collecting the next ensemble immediately after processing the previous ensemble.
Example	:	TE01153000 tells the ADCP to collect data ensembles every 1 hour, 15 minutes, 30 seconds.
Notes	:	The ADCP automatically increases TE if ((WP + NP + BP) x TP > TE). The time tag for each ensemble is the time of the first ping of that ensemble, not the time of output.

TP - Time Between Pings

Purpose	:	Sets the *minimum* time between pings.
Format	:	TP*mm:ss.ff*
Range	:	*mm* = 00 to 59 minutes *ss* = 00 to 59 seconds *ff* = 00 to 99 hundredths of seconds
Default	:	TP000300 (38kHz), TP000200 (75kHz), TP000100 (150kHz)

Description	:	The ADCP interleaves individual pings within a group so they are evenly spread throughout the ensemble. During the ensemble interval set by TE, the ADCP transmits the number of pings set by the WP,NP, and BP commands. TP determines the spacing between the pings. If TP = 0, the ADCP pings as quickly as it can based on the time it takes to transmit each ping plus the overhead that occurs for processing.
Example	:	TP00:00.10 sets the time between pings to 0.10 second.
Note	:	The ADCP automatically increases TE if ((WP + NP + BP) x TP > TE).

TS - Set System Date and Time

Purpose	:	Sets the ADCP's internal clock.
Format	:	TS*yymmddhhmmss*
Range	:	*yy* = year 00-99 *mm* = month 01-12 *dd* = day 01-31 *hh* = hours 00-23 *mm* = minutes 00-59 *ss* = seconds 0-59
Description	:	When the ADCP receives the carriage return after the TS-command, it enters the new time into the clock and sets hundredths of seconds to zero. The clock will continue to function through and after the transition from 2359 31DEC1999 to 0000 1JAN2000. The clock is also aware of leap years and the fact that 2000 is a leap year.
Example	:	TS000617131500 sets the clock to 1:15:00 pm, June 17, 2000.

3.10 Broad Bandwidth Water-Profiling Commands

The following commands define the criteria used to collect the Broad Bandwidth (or Wide Bandwidth) water-profile data.

WA – Broad Bandwidth Profiling False Target Threshold

Purpose	:	Sets a false target (fish) filter
Format	:	WA*n*
Range	:	*n* = 0 to 255 counts
Default	:	WA255
Description	:	The ADCP uses the WA-command to screen profile data for false targets (usually fish). WA sets the maximum difference between echo intensity readings among the four profiling beams. If the WA threshold value is exceeded, the ADCP rejects velocity data on a cell-by-cell basis for either the affected beam (fish detected in only one beam) or for the affected cell in all four beams (fish detected in more than one beam). This usually occurs when fish pass through one or more beams.
Notes	:	A WA value of 255 disables this feature. A typical setting is 55 to 75.

> **NOTE.** The default setting for this command is recommended for most applications.

WC - Broad Bandwidth Profiling Water Correlation Threshold

Purpose	:	Sets the minimum correlation for valid velocity data.
Format	:	WC*nnn*
Range	:	*nnn* = 0 to 255 counts
Default	:	WC120
Description	:	The ADCP uses WC to screen water-track data for the minimum acceptable correlation requirements. WC sets the threshold of this correlation below which the ADCP flags the data as bad.
Note	:	The default threshold for all Ocean Surveyor frequencies is 120 counts. A solid target would have a correlation of 255 counts.

> **NOTE.** The default setting for this command is recommended for most applications.

WD - Broad Bandwidth Profiling Data Out

Purpose	:	Selects the data types collected by the ADCP.
Format	:	WD *abc de*0 000
Range	:	Firmware switches (see description)
Default	:	WD111 110 000
Description	:	WD uses firmware switches to tell the ADCP the types of data to collect. The ADCP always collects header data, fixed/variable leader data, and checksum data. Setting a bit to 1 tells the ADCP to collect that data type. The bits are described as follows:

a = Velocity
b = Correlation
c = Echo Intensity
d = Percent Good
e = Status

Example	:	WD 111 110 000 (default) tells the ADCP to collect velocity, correlation magnitude, echo intensity, percent good, and status.
Notes	:	1. Each bit can have a value of one or zero: one means output data; zero means suppress data.
		2. If WP = 0, the ADCP does not collect water-track data.
		3. Spaces in the command line are allowed.

NOTE. The default setting for this command is recommended for most applications.

WE - Broad Bandwidth Profiling Error Velocity Threshold

Purpose	:	Sets the maximum error velocity for good profile data.
Format	:	WE*nnnn*
Range	:	*n* = 0 to 9999 mm/s
Default	:	WE1000
Description	:	The WE-command sets a threshold value used to flag water-current data as good or bad. If the ADCP's error velocity value exceeds this threshold, it flags data as bad for a given depth cell. The WE-command screens for error velocities in both beam and transformed-coordinate data.

CAUTION. The default setting is set purposely high. We recommend extreme caution and testing before changing this setting. **Data rejected by this command is lost and cannot be regained.**

WF - Broad Bandwidth Profiling Blank after Transmit

Purpose : Moves the location of first depth cell away from the transducer head to allow the transmit circuits time to recover before the receive cycle begins.

Format : WF*nnnn*

Range : *nnnn* = 0 to 9999 cm (328 feet)

Default : WF1600 (38kHz), WF800 (75kHz), WF400 (150kHz)

Description : WF positions the start of the first depth cell at some vertical distance from the transducer head. This allows the ADCP transmit circuits time to recover before beginning the receive cycle. In effect, WF blanks out bad data close to the transducer head, thus creating a depth window that reduces unwanted data in the ensemble.

Notes : Small WF values may show ringing/recovery problems in the first depth cells that cannot be screened by the ADCP. We recommend you set WF to no less than the default value.

NOTE. The default setting for this command is recommended for most applications.

WN - Broad Bandwidth Profiling Number Of Depth Cells

Purpose : Sets the number of depth cells over which the ADCP collects data.

Format : WN*nnn*

Range : *nnn* = 001 to 128 depth cells

Default : WN128

Description : The range of the ADCP is set by the number of depth cells (WN) times the size of each depth cell (WS).

WP - Broad Bandwidth Profiling Pings Per Ensemble

Purpose : Sets the number of broadband profile pings to average together in each data ensemble.

Format : WP*nnn*

Range : *nnn* = 0 to 999 pings

Default : WP1

Description : WP sets the number of broadband profile pings to average together in each ensemble before sending profile data.

Notes	:	The ADCP interleaves profile pings with bottom-track pings (see TP-command). If WP = zero, the ADCP does not collect broadband profile data.

NOTE. When using *VmDas*, the typical setup will use single ping (WP1) when doing Broad Bandwidth profiling.

WS - Broad Bandwidth Profiling Depth Cell Size

Purpose	:	Selects the volume of water for one measurement cell.
Format	:	WS*nnnn*
Range	:	*n* = 80 to 6400 cm for 38kHz systems. *n* = 40 to 3200 cm for 75kHz systems. *n* = 20 to 1600 cm for 150kHz systems.
Default	:	WS3200 (38kHz), WS1600 (75kHz), WS800 (150kHz)
Description	:	WN Sets the size of depth cells over which the ADCP collects data. The range of the profile is set by the number of depth cells (WN) times the size of each depth cell (WS).

WV - Broad Bandwidth Profiling Ambiguity Velocity

Purpose	:	Sets the radial ambiguity velocity for broadband profiling.
Format	:	WV*nnn*
Range	:	*nnn* = 0 to 390 cm/s
Default	:	WV390
Description	:	WV sets the radial ambiguity velocity for broadband profiling. Velocities above this value may cause ambiguity errors.

NOTE. It is strongly recommended that the WV command be left at its' default value of 390.

Narrow Bandwidth Mode Ambiguity

With the default setup, the beam-radial ambiguity velocity Ua is 450 cm/s. The formula for calculating the max speed in Narrow Bandwidth mode is:

NBmax = Ua / sin(beam angle) / cos(rotation angle)

For a 45-degree rotation, this gives a max horizontal speed of 12.7 m/s or about 25 knots.

Broad Bandwidth Mode Ambiguity

The maximum WV setting is 390 cm/s. This is because the PA transducer cannot produce a bandwidth wider than that to support larger ambiguity settings (smaller lags than 390 cm/s). Therefore, we have added the capability to offset the ambiguity lane. The equation for calculating the max speed in Broad Bandwidth mode is:

BBmax = (Ua + offset) / sin(beam angle) / cos(rotation angle)

The default offset values (&W+00,+00,+195,-195) assume that beam 3 is forward and have values of:

beam 1: 0
beam 2: 0
beam 3: +195 cm/s
beam 4: -195 cm/s

Consequently, the default max speed in Broad Bandwidth mode for a 45-degree rotation is:

beam 1: -11 m/s to + 11 m/s
beam 2: -11 m/s to + 11 m/s
beam 3: -5.5 m/s to + 16.5 m/s
beam 4: -5.5 m/s to + 16.5 m/s

Which means the maximum speed is effectively 11 ms/ (22 knots). You can raise the maximum speed to 16.5 m/s (33 knots) by setting the ambiguity offset with &W +195,-195,+195,-195.

> **NOTE.** If you set WV above 390, the system will still use 390 because it will not use a shorter lag. No errors will occur by using higher values of WV390.

NOTES

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4 Introduction to Output Data Format

This guide shows the format of the VmDas Short Term Average (STA) and Long Term Average (LTA) files when using an Ocean Surveyor ADCP (firmware version 23.xx and higher). The VmDas STA and LTA output can only be binary. We explain the output data formats in enough detail to let you create your own data processing or analysis programs.

NOTE. This guide applies to Ocean Surveyor firmware version 23.11. When new firmware versions are released, some output data formats may be modified or added. Read the README file on the upgrade disk, or check RDI's web site for the latest changes.

5 Binary Output and VmDas

The Ocean Surveyor binary output data buffer contains header data, leader data, velocity, correlation magnitude, echo intensity, percent good, and a checksum. The Ocean Surveyor collects all data in the output buffer during an ensemble. The *VmDas* program writes this Ocean Surveyor output into the *.ENR files and then inserts the navigation data before the checksum (and reserved bytes) when it saves the *.STA and *.LTA files.

Figure 4, page 50 shows the format of this buffer and the sequence in which the VmDas program creates the *.STA and *.LTA files. Figure 6, page 52 through Figure 16, page 82 show the format of the individual items that make up the binary output buffer. Table 10, page 52 through Table 23, page 82 lists the format, bytes, fields, scaling factors, and a detailed description of every item in the binary output buffer.

5.1 Binary Standard Output Data Buffer Format

Always Output	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	FIXED LEADER DATA (50 BYTES)
	VARIABLE LEADER DATA (58 BYTES)
WD **or** ND command WP **or** NP command	**VELOCITY** (2 BYTES + 8 BYTES PER DEPTH CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
	STATUS (2 BYTES + 4 BYTES PER DEPTH CELL)
BP command	**BOTTOM-TRACK** (81 BYTES)
	FIXED ATTITUDE (41 BYTES)
	VARIABLE ATTITUDE (12 BYTES PER DATA TYPE)
	NAVIGATION (78 BYTES) (*VmDas* ENS, ENX, STA, and LTA files only)
Always Output	**RESERVED** (2 BYTES)
	CHECKSUM (2 BYTES)

Figure 4. Binary Standard Output Data Buffer Format (WP or NP Command)

NOTE. Figure 4 shows the binary output data buffer format when WP > zero or NP > zero (one or the other, not both). See Figure 5, page 51 for the output buffer when both WP and NP > zero.

Always Output	**HEADER** (6 BYTES + [2 x No. OF DATA TYPES])
	FIXED LEADER DATA (50 BYTES)
	VARIABLE LEADER DATA (58 BYTES)
WD command WP command	**VELOCITY** (2 BYTES + 8 BYTES PER DEPTH CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
	STATUS (2 BYTES + 4 BYTES PER DEPTH CELL)
BP command	**BOTTOM-TRACK** (81 BYTES)
	VARIABLE LEADER DATA (58 BYTES)
ND command NP command	**VELOCITY** (2 BYTES + 8 BYTES PER DEPTH CELL)
	CORRELATION MAGNITUDE (2 BYTES + 4 BYTES PER DEPTH CELL)
	ECHO INTENSITY (2 BYTES + 4 BYTES PER DEPTH CELL)
	PERCENT GOOD (2 BYTES + 4 BYTES PER DEPTH CELL)
	STATUS (2 BYTES + 4 BYTES PER DEPTH CELL)
BP command	**BOTTOM-TRACK** (81 BYTES)
	FIXED ATTITUDE (41 BYTES)
	VARIABLE ATTITUDE (12 BYTES PER DATA TYPE)
	NAVIGATION (78 BYTES) (*VmDas* ENS, ENX, STA, and LTA files only)
Always Output	**RESERVED** (2 BYTES)
	CHECKSUM (2 BYTES)

Figure 5. Binary Standard Output Data Buffer Format (WP and NP Command)

Some data outputs are in bytes per depth cell. For example, if the WN-command (number of depth cells) = 23, and the following data are selected for output, the required data buffer storage space is 780 bytes per ensemble:

WD-Command =WD 111 100 000 (default), WP-Command = zero, BP-Command > zero, NP-Command > zero, EE-Command = EE11111100 (Default)

```
50   Bytes of Header Data (6+2x8)
58   Bytes of Fixed Leader Data (fixed)
42   Bytes of Variable Leader Data (fixed)
186  Bytes of Velocity Data (2+8x23)
94   Bytes of Correlation Magnitude Data (2+4x23)
94   Bytes of Echo Intensity (2+4x23)
81   Bytes of Bottom Track Data (fixed)
43   Bytes of Fixed Attitude Data (fixed)
50   Bytes of Variable Attitude Data (2+4x12)
78   Bytes of Navigation Data (fixed)
2    Bytes of Reserved for RDI Use (fixed)
2    Bytes of Checksum Data (fixed)
--------------------------------------------
780  Bytes of data per ensemble
```

5.2 Binary Header Data Format

BIT POSITIONS

BYTE	7	6	5	4	3	2	1	0	
1	HEADER ID (7Fh)								
2	DATA SOURCE ID (7Fh)								
3	NUMBER OF BYTES IN ENSEMBLE								LSB
4									MSB
5	SPARE								
6	NUMBER OF DATA TYPES								
7	OFFSET FOR DATA TYPE #1								LSB
8									MSB
9	OFFSET FOR DATA TYPE #2								LSB
10									MSB
11	OFFSET FOR DATA TYPE #3								LSB
12									MSB
↓	(SEQUENCE CONTINUES FOR UP TO N DATA TYPES)								↓
2N+5	OFFSET FOR DATA TYPE #N								LSB
2N+6									MSB

Figure 6. Binary Header Data Format

NOTE. This data is always output in this format.

Header information is the first item sent by the ADCP to the output buffer. The ADCP always sends the Least Significant Byte (LSB) first.

Table 10: Binary Header Data Format

Hex Digit	Binary Byte	Field	Description
1,2	1	HDR ID / Header ID	Stores the header identification byte (7Fh).
3,4	2	HDR ID / Data Source ID	Stores the data source identification byte (7Fh for the ADCP).
5-8	3,4	Bytes / Number of bytes in ensemble	This field contains the number of bytes from the start of the current ensemble up to, but not including, the 2-byte checksum.
9,10	5	Spare	Undefined.
11,12	6	No. DT / Number of Data Types	This field contains the number of data types selected for collection. By default, fixed/variable leader, velocity, correlation magnitude, echo intensity, and percent-good are selected for collection. This field will therefore have a default value of six (4 data types + 2 for the Fixed/Variable Leader data).

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Table 10: Binary Header Data Format (continued)

Hex Digit	Binary Byte	Field	Description
13-16	7,8	Address Offset for Data Type #1 / Offset for Data Type #1	This field contains the internal memory address offset where the ADCP will store information for data type #1 (with this firmware, always the Fixed Leader). Adding "1" to this offset number gives the absolute Binary Byte number in the ensemble where Data Type #1 begins (the first byte of the ensemble is Binary Byte #1).
17-20	9,10	Address Offset for Data Type #2 / Offset for Data Type #2	This field contains the internal memory address offset where the ADCP will store information for data type #2 (with this firmware, always the Variable Leader). Adding "1" to this offset number gives the absolute Binary Byte number in the ensemble where Data Type #2 begins (the first byte of the ensemble is Binary Byte #1).
21-24 thru 2n+13 to 2n+16	11,12 thru 2n+5, 2n+6	Address Offsets for Data Types #3-n / Offset for Data Type #3 through #n	These fields contain internal memory address offset where the ADCP will store information for data type #3 through data type #n. Adding "1" to this offset number gives the absolute Binary Byte number in the ensemble where Data Types #3-n begin (first byte of ensemble is Binary Byte) #1).

5.3 Binary Fixed Leader Data Format

BIT POSITIONS

BYTE	7 6 5 4 3 2 1 0		
1	FIXED LEADER ID	00h	LSB
2		00h	MSB
3	CPU F/W VER.		
4	CPU F/W REV.		
5	SYSTEM CONFIGURATION		LSB
6			MSB
7	RESERVED		
8			
9	NUMBER OF BEAMS		
10	NUMBER OF CELLS {WN}		
11	NUMBER OF PINGS		LSB
12			MSB
13	DEPTH CELL LENGTH {WS}		LSB
14			MSB
15	BLANK AFTER TRANSMIT {WF}		LSB
16			MSB
17	SIGNAL PROCESSING MODE		
18	BROAD BANDWIDTH PROFILING WATER CORRELATION THRESHOLD		
19	NUMBER CODE REPS		

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Continued From Previous Page

BYTE	BIT POSITIONS 7 6 5 4 3 2 1 0	
20	PERCENT GOOD MINIMUM {WG}	
21	ERROR VELOCITY MAXIMUM {WE}	
22		
23	TPP MINUTES	
24	TPP SECONDS	
25	TPP HUNDREDTHS {TP}	
26	COORDINATE TRANSFORMATION {EX}	
27	HEADING ALIGNMENT {EA}	LSB
28		MSB
29	HEADING BIAS {EB}	LSB
30		MSB
31	SENSOR SOURCE {EZ}	
32	SENSORS AVAIL	
33	BIN 1 DISTANCE	LSB
34		MSB
35	XMIT PULSE LENGTH	LSB
36	BASED ON {WT}	MSB
37	REF LAYER (starting cell)	
38	REF LAYER (ending cell)	
39	FALSE TARGET THRESH {WA}	
40	RESERVED	
41	TRANSMIT LAG DISTANCE	LSB
42		MSB
43	RESERVED	
↓		↓
50		

Figure 7. Binary Fixed Leader Data Format

NOTE. This data is always output in this format.

Fixed Leader data refers to the non-dynamic ADCP data that only changes when you change certain commands. Fixed Leader data also contain hardware information. The ADCP always sends Fixed Leader data as output data (LSBs first). See “Command Descriptions,” page 6 for detailed descriptions of commands used to set these values.

Table 11: Binary Fixed Leader Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	FID / Fixed Leader ID	Stores the Fixed Leader identification word (00 00h).
5,6	3	fv / CPU F/W Ver.	Contains the version number of the CPU firmware.
7,8	4	fr / CPU F/W Rev.	Contains the revision number of the CPU firmware.
9-12	5,6	Sys Cfg / System Configuration	This field defines the ADCP hardware configuration. Convert this field (2 bytes, LSB first) to binary and interpret as follows. LSB BITS 7 6 5 4 3 2 1 0 - - - - - 0 0 0 75-kHz SYSTEM - - - - - 0 0 1 150-kHz SYSTEM - - - - - 0 1 0 300-kHz SYSTEM - - - - - 0 1 1 600-kHz SYSTEM - - - - - 1 0 0 1200-kHz SYSTEM - - - - - 1 0 1 2400-kHz SYSTEM - - - - - 1 1 0 38-kHz SYSTEM - - - - 0 - - - CONCAVE BEAM PAT. - - - - 1 - - - CONVEX BEAM PAT. - - 0 0 - - - - SENSOR CONFIG #1 - - 0 1 - - - - SENSOR CONFIG #2 - - 1 0 - - - - SENSOR CONFIG #3 - 0 - - - - - - XDCR HD NOT ATT. - 1 - - - - - - XDCR HD ATTACHED 0 - - - - - - - DOWN FACING BEAM 1 - - - - - - - UP-FACING BEAM MSB BITS 7 6 5 4 3 2 1 0 - - - - - - 0 0 15E BEAM ANGLE - - - - - - 0 1 20E BEAM ANGLE - - - - - - 1 0 30E BEAM ANGLE - - - - - - 1 1 OTHER BEAM ANGLE 0 1 0 0 - - - - 4-BEAM JANUS CONFIG 0 1 0 1 - - - - 5-BM JANUS CFIG DEMOD) 1 1 1 1 - - - - 5-BM JANUS CFIG.(2 DEMD) Example: Hex 5249 (i.e., hex 49 followed by hex 52) identifies a 150-kHz system, convex beam pattern, down-facing, 30E beam angle, 5 beams (3 demods).
13,14	7	Reserved	Always 0
15,16	8	Reserved	Always 0
17,18	9	#Bm / Number of Beams	Contains the number of beams used to calculate velocity data (not physical beams). The ADCP needs only three beams to calculate water-current velocities. The fourth beam provides an error velocity that determines data validity. If only three beams are available, the ADCP does not make this validity check. The Percent-Good Data Format has more information.
19,20	10	WN / Number of Cells	Contains the number of depth cells over which the ADCP collects data (WN-command). Scaling: LSD = 1 depth cell; Range = 1 to 128 depth cells

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Table 11: Binary Fixed Leader Data Format (continued)

Hex Digit	Binary Byte	Field	Description
21-24	11,12	WP / Pings Per Ensemble	Contains the number of pings averaged together during a data ensemble (WP-command). If WP = 0, the Ocean Surveyor does not collect the WD water-profile data. Note: The Ocean Surveyor automatically extends the ensemble interval (TE) if the product of WP and time per ping (TP) is greater than TE (i.e., if WP x TP > TE). Scaling: LSD = 1 ping; Range = 0 to 16,384 pings
25-28	13,14	WS / Depth Cell Length	Contains the length of one depth cell (WS-command). Scaling: LSD = 1 centimeter; Range = 1 to 6400 cm (210 feet)
29-32	15,16	WF / Blank after Transmit	Contains the blanking distance used by the ADCP to allow the transmit circuits time to recover before the receive cycle begins (WF-command). Scaling: LSD = 1 centimeter; Range = 0 to 9999 cm (328 feet)
33,34	17	Signal Processing Mode	If the profile ping was a broadband ping then it will show 1. If the ping was a narrowband ping then it will show 10.
35,36	18	WC / Broad Bandwidth Profiling Water Correlation Threshold	If the profile ping was a broadband ping, then byte 18 is the value of WC. If the profile ping was a narrowband ping then it is zero.
37,38	19	cr# / No. code reps	Contains the number of code repetitions in the transmit pulse. Scaling: LSD = 1 count; Range = 0 to 255 counts
39,40	20	WG / %Gd Minimum	Contains the minimum percentage of water-profiling pings in an ensemble that must be considered good to output velocity data (WG-command). Scaling: LSD = 1 percent; Range = 1 to 100 percent
41-44	21,22	WE / Error Velocity Threshold	This field, initially set by the WE-command, contains the actual threshold value used to flag water-current data as good or bad. If the error velocity value exceeds this threshold, the Workhorse flags all four beams of the affected bin as bad. Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s
45,46	23	Minutes	These fields, set by the TP-command, contain the amount of time between ping groups in the ensemble. NOTE: The Ocean Surveyor automatically extends the ensemble interval (set by TE) if (WP x TP > TE).
47,48	24	Seconds	
49,50	25	Hundredths	

51,52	26	EX / Coord Transform	Contains the coordinate transformation processing parameters (EX-command). These firmware switches indicate how the Ocean Surveyor collected data.
			`xxx00xxx = NO TRANSFORMATION (BEAM COORDINATES)`
			`xxx01xxx = INSTRUMENT COORDINATES`
			`xxx10xxx = SHIP COORDINATES`
			`xxx11xxx = EARTH COORDINATES`
			`xxxxx1xx = TILTS (PITCH AND ROLL) USED IN SHIP OR EARTH TRANSFORMATION`
			`xxxxxx1x = 3-BEAM SOLUTION USED IF ONE BEAM IS BELOW THE CORRELATION THRESHOLD SET BY THE WC-COMMAND`
			`xxxxxxx1 = BIN MAPPING USED`

Table 11: Binary Fixed Leader Data Format (continued)

Hex Digit	Binary Byte	Field	Description
53-56	27,28	EA / Heading Alignment	Contains a correction factor for physical heading misalignment (EA-command). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees
57-60	29,30	EB / Heading Bias	Contains a correction factor for electrical/magnetic heading bias (EB-command). Scaling: LSD = 0.01 degree; Range = -179.99 to 180.00 degrees

61,62	31	EZ / Sensor Source	Contains the selected source of environmental sensor data (EZ-command). These firmware switches indicate the following.
			
			`Field     Description`
			`x1xxxxxx = calculates EC from ED, ES, and ET`
			`xx1xxxxx = uses ED from depth sensor`
			`xxx1xxxx = uses EH from transducer heading sensor`
			`xxxx1xxx = uses EP from transducer pitch sensor`
			`xxxxx1xx = uses ER from transducer roll sensor`
			`xxxxxx1x = uses ES from conductivity sensor`
			`xxxxxxx1 = uses ET from transducer temp sensor`
			
			NOTE: If the field = 0, or if the sensor is not available, the ADCP uses the manual command setting. If the field = 1, the ADCP uses the reading from the internal sensor or an external synchro sensor (only applicable to heading, roll, and pitch). Although you can enter a "2" in the EZ-command string, the ADCP only displays a 0 (manual) or 1 (int/ext sensor).

63,64	32	SA / Sensors Avail	This field reflects what sensors are available. The bit pattern is the same as listed for the EZ-command (above), except that the EC bit is always zero because there is no speed of sound sensor.
65-68	33,34	dis1 / Bin 1 distance	This field contains the distance to the middle of the first depth cell (bin). This distance is a function of depth cell length (WS), the profiling mode (WM), the blank after transmit distance (WF), and speed of sound. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
69-72	35,36	WT Xmit pulse length	This field, set by the WT-command, contains the length of the transmit pulse. When the ADCP receives a <BREAK> signal, it sets the transmit pulse length as close as possible to the depth cell length (WS-command). This means the ADCP uses an WT command of zero. However, the WT field contains the actual length of the transmit pulse used. Scaling: LSD = 1 centimeter; Range = 0 to 65535 cm (2150 feet)
73-76	37,38	Reserved	Always 1,1
77,78	39	Reserved	Always 0
79,80	40	Reserved	Always 0
81-84	41,42	LagD / Transmit lag distance	This field, determined mainly by the setting of the WM-command, contains the distance between pulse repetitions. Scaling: LSD = 1 centimeter; Range = 0 to 65535 centimeters

5.4 Binary Variable Leader Data Format

BYTE	BIT POSITIONS 7 6 5 4 3 2 1 0		
1	VAR LEADER ID	80h	LSB
2		00h	MSB
3	ENSEMBLE		LSB
4	NUMBER		MSB
5	SYSTEM DATE YEAR		
6	MONTH		
7	DAY		
8	SYSTEM TIME HOUR		
9	MINUTE		
10	SECOND		
11	HUNDREDTHS		
12	ENSEMBLE # MSB		
13	RESERVED		LSB
14			MSB
15	SPEED OF SOUND {EC}		LSB
16			MSB
17	DEPTH OF TRANSDUCER {ED}		LSB
18			MSB
19	HEADING {EH}		LSB
20			MSB
21	PITCH (TILT 1) {EP}		LSB
22			MSB
23	ROLL (TILT 2) {ER}		LSB
24			MSB
25	SALINITY {ES}		LSB
26			MSB
27	TEMPERATURE {ET}		LSB
28			MSB
29 ↓ 58	RESERVED		

Figure 8. Binary Variable Leader Data Format

NOTE. This data is always output in this format.

Variable Leader data refers to the dynamic ADCP data (from clocks and sensors) that change with each ping. The ADCP always sends Variable Leader data as output data (LSBs first). See "Command Descriptions," page 6 for detailed descriptions of commands used to set these values.

Table 12: Binary Variable Leader Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VID / Variable Leader ID	Stores the Variable Leader identification word (80 00h).

5-8	3,4	Ens / Ensemble Number	This field contains the sequential number of the ensemble to which the data in the output buffer apply.
			Scaling: LSD = 1 ensemble; Range = 1 to 65,535 ensembles
			NOTE: The first ensemble collected is #1. At "rollover," we have the following sequence:
			`1 = ENSEMBLE NUMBER 1`
			↓
			`65535 = ENSEMBLE NUMBER 65,535 ┌ ENSEMBLE`
			`0 = ENSEMBLE NUMBER 65,536 │ #MSB FIELD`
			`1 = ENSEMBLE NUMBER 65,537 └ (BYTE 12) INCR.`

9,10	5	RTC Year	These fields contain the time from the ADCP's real-time clock (RTC) that the current data ensemble began. The TS-command (Set Real-Time Clock) initially sets the clock. The ADCP <u>does</u> account for leap years.
11,12	6	RTC Month	
13,14	7	RTC Day	
15,16	8	RTC Hour	
17,18	9	RTC Minute	
19,22	10	RTC Second	
21,22	11	RTC Hundredths	
23-24	12	Ensemble # MSB	This field increments each time the Ensemble Number field (bytes 3,4) "rolls over." This allows ensembles up to 16,777,215. See Ensemble Number field above.
25-28	13,14	Reserved	Always 0
29-32	15,16	EC / Speed of Sound	Contains either manual or calculated speed of sound information (EC-command). Scaling: LSD = 1 meter per second; Range = 1400 to 1600 m/s
33-36	17,18	ED / Depth of Transducer	Contains the depth of the transducer below the water surface (ED-command). This value may be a manual setting or a reading from a depth sensor. Scaling: LSD = 1 decimeter; Range = 1 to 9999 decimeters
37-40	19,20	EH / Heading	Contains the ADCP heading angle (EH-command). This value may be a manual setting or a reading from a heading sensor. Scaling: LSD = 0.01 degree; Range = 000.00 to 359.99 degrees

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Table 12: Binary Variable Leader Data Format (continued)

Hex Digit	Binary Byte	Field	Description
41-44	21,22	EP / Pitch (Tilt 1)	Contains the ADCP pitch angle (EP-command). This value may be a manual setting or a reading from a tilt sensor. Positive values mean that Beam #3 is spatially higher than Beam #4. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
45-48	23,24	ER / Roll (Tilt 2)	Contains the ADCP roll angle (ER-command). This value may be a manual setting or a reading from a tilt sensor. For up-facing ADCPs, positive values mean that Beam #2 is spatially higher than Beam #1. For down-facing ADCPs, positive values mean that Beam #1 is spatially higher than Beam #2. Scaling: LSD = 0.01 degree; Range = -20.00 to +20.00 degrees
49-52	25,26	ES / Salinity	Contains the salinity value of the water at the transducer head (ES-command). This value may be a manual setting or a reading from a conductivity sensor. Scaling: LSD = 1 part per thousand; Range = 0 to 40 ppt
53-56	27,28	ET / Temperature	Contains the temperature of the water at the transducer head (ET-command). This value may be a manual setting or a reading from a temperature sensor. Scaling: LSD = 0.01 degree; Range = -5.00 to +40.00 degrees
57-84	29-58	Reserved	Always 0

5.5 Binary Velocity Data Format

BIT POSITIONS

BYTE	7/S	6	5	4	3	2	1	0	
1	VELOCITY ID							00h	LSB
2								01h	MSB
3	DEPTH CELL #1, VELOCITY 1								LSB
4									MSB
5	DEPTH CELL #1, VELOCITY 2								LSB
6									MSB
7	DEPTH CELL #1, VELOCITY 3								LSB
8									MSB
9	DEPTH CELL #1, VELOCITY 4								LSB
10									MSB
11	DEPTH CELL #2, VELOCITY 1								LSB
12									MSB
13	DEPTH CELL #2, VELOCITY 2								LSB
14									MSB
15	DEPTH CELL #2, VELOCITY 3								LSB
16									MSB
17	DEPTH CELL #2, VELOCITY 4								LSB
18									MSB
↓	(SEQUENCE CONTINUES FOR UP TO 128 CELLS)								↓
1019	DEPTH CELL #128, VELOCITY 1								LSB
1020									MSB
1021	DEPTH CELL #128, VELOCITY 2								LSB
1022									MSB
1023	DEPTH CELL #128, VELOCITY 3								LSB
1024									MSB
1025	DEPTH CELL #128, VELOCITY 4								LSB
1026									MSB

Figure 9. Binary Velocity Data Format

NOTE. The number of depth cells is set by the WN-command.

The ADCP packs velocity data for each depth cell of each beam into a two-byte, two's-complement integer [-32768, 32767] with the LSB sent first. The ADCP scales velocity data in millimeters per second (mm/s). A value of -32768 (8000h) indicates bad velocity values.

Table 13: Binary Velocity Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Velocity ID	Stores the velocity data identification word (00 01h).
5-8	3,4	Depth Cell 1, Velocity 1	Stores velocity data for depth cell #1, velocity 1. See above.
9-12	5,6	Depth Cell 1, Velocity 2	Stores velocity data for depth cell #1, velocity 2. See above.
13-16	7,8	Depth Cell 1, Velocity 3	Stores velocity data for depth cell #1, velocity 3. See above.
17-20	9,10	Depth Cell 1, Velocity 4	Stores velocity data for depth cell #1, velocity 4. See above.
21-2052	11-1026	Cells 2 - 128 (if used)	These fields store the velocity data for depth cells 2 through 128 (depending on the setting of the WN-command). These fields follow the same format as listed above for depth cell 1.

5.6 Binary Correlation Magnitude, Echo Intensity, and Status Data Format

BIT POSITIONS

BYTE	7/S	6	5	4	3	2	1	0	
1	ID CODE								LSB
2									MSB
3	DEPTH CELL #1, FIELD #1								
4	DEPTH CELL #1, FIELD #2								
5	DEPTH CELL #1, FIELD #3								
6	DEPTH CELL #1, FIELD #4								
7	DEPTH CELL #2, FIELD #1								
8	DEPTH CELL #2, FIELD #2								
9	DEPTH CELL #2, FIELD #3								
10	DEPTH CELL #2, FIELD #4								
↓	(SEQUENCE CONTINUES FOR UP TO 128 BINS)								↓
511	DEPTH CELL #128, FIELD #1								
512	DEPTH CELL #128, FIELD #2								
513	DEPTH CELL #128, FIELD #3								
514	DEPTH CELL #128, FIELD #4								

Figure 10. Binary Correlation Magnitude, Echo Intensity, and Status Data Format

NOTE. The number of depth cells is set by the WN-command.

Correlation magnitude data for Broad Bandwidth ensembles give the magnitude of the normalized echo autocorrelation at the lag used for estimating the Doppler phase change. The ADCP represents this magnitude by a linear scale between 0 and 255, where 255 is perfect correlation (i.e., a solid target).

Correlation magnitude data for Narrow Bandwidth ensembles give the magnitude of the energy (power) in the low pass filter. Values of 170 to 190 counts represent normal levels. Lower values mean a reduced signal to noise ratio.

Table 14: Binary Correlation Magnitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the correlation magnitude data identification word (00 02h).
5,6	3	Depth Cell 1, Field 1	Stores correlation magnitude data for depth cell #1, beam #1. See above.
7,8	4	Depth Cell 1, Field 2	Stores correlation magnitude data for depth cell #1, beam #2. See above.
9,10	5	Depth Cell 1, Field 3	Stores correlation magnitude data for depth cell #1, beam #3. See above.
11,12	6	Depth Cell 1, Field 4	Stores correlation magnitude data for depth cell #1, beam #4. See above.
13- 1028	7- 514	Cells 2 - 128 (if used)	These fields store correlation magnitude data for depth cells 2 through 128 (depending on the WN-command) for all four beams. These fields follow the same format as listed above for depth cell 1.

The echo intensity scale factor is about 0.45 dB per ADCP count. The ADCP does not directly check for the validity of echo intensity data.

Table 15: Binary Echo Intensity Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the echo intensity data identification word (00 03h).
5,6	3	Depth Cell 1, Field 1	Stores echo intensity data for depth cell #1, beam #1. See above.
7,8	4	Depth Cell 1, Field 2	Stores echo intensity data for depth cell #1, beam #2. See above.
9,10	5	Depth Cell 1, Field 3	Stores echo intensity data for depth cell #1, beam #3. See above.
11,12	6	Depth Cell 1, Field 4	Stores echo intensity data for depth cell #1, beam #4. See above.
13-1028	7-514	Cells 2 - 128 (if used)	These fields store echo intensity data for depth cells 2 through 128 (depending on the WN-command) for all four beams. These fields follow the same format as listed above for depth cell 1.

These fields contain information about the status and quality of ADCP data. A value of zero means the measurement was good. A value of one means the measurement was bad.

Table 16: Binary ADCP Status Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the status data identification word (00 05h).
5,6	3	Depth cell 1, Field 1	Stores status data for depth cell #1, beam #1. See above.
7,8	4	Depth cell 1, Field 2	Stores status data for depth cell #1, beam #2. See above.
9,10	5	Depth cell 1, Field 3	Stores status data for depth cell #1, beam #3. See above.
11,12	6	Depth cell 1, Field 4	Stores status data for depth cell #1, beam #4. See above.
13 - 1028	7 - 514	Depth cells 2 - 128 (if used)	These fields store status data for depth cells 2 through 128 (depending on the WN-command) for all four beams. These fields follow the same format as listed above for depth cell 1.

5.7 Binary Bottom-Track Data Format

BIT POSITIONS

BYTE#	7 6 5 4 3 2 1 0	
1	BOTTOM-TRACK ID 00h	LSB
2	06h	MSB
3	BOTTOM-TRACK # OF PINGS {BP}	LSB
4		MSB
5	RESERVED	LSB
6		MSB
7	BT CORR MAG MIN {BC}	
8	BT EVAL AMP MIN {BA}	
9	RESERVED	
10	BOTTOM TRACK MODE {BM}	
11	ERROR VELOCITY MAXIMUM {BE}	
12		
13	RESERVED	
↓		↓
16		
17	BEAM#1 BT RANGE	LSB
18		MSB
19	BEAM#2 BT RANGE	LSB
20		MSB
21	BEAM#3 BT RANGE	LSB
22		MSB
23	BEAM#4 BT RANGE	LSB
24		MSB
25	BEAM#1 BT VEL	LSB
26		MSB
27	BEAM#2 BT VEL	LSB
28		MSB
29	BEAM#3 BT VEL	LSB
30		MSB
31	BEAM#4 BT VEL	LSB
32		MSB
33	BEAM#1 BT CORR.	
34	BEAM#2 BT CORR.	
35	BEAM#3 BT CORR.	

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36	BEAM#4 BT CORR.	
37	BEAM#1 EVAL AMP	
38	BEAM#2 EVAL AMP	
39	BEAM#3 EVAL AMP	
40	BEAM#4 EVAL AMP	
41 ↓ 70	RESERVED	↓
71	BT MAXIMUM DEPTH {BX}	LSB
72		MSB
73	BM#1 RSSI AMP	
74	BM#2 RSSI AMP	
75	BM#3 RSSI AMP	
76	BM#4 RSSI AMP	
77	GAIN	
78	(*SEE BYTE 17)	MSB
79	(*SEE BYTE 19)	MSB
80	(*SEE BYTE 21)	MSB
81	(*SEE BYTE 23)	MSB

Figure 11. Binary Bottom-Track Data Format

> **NOTE.** This data is output only if the BP-command is >0 and PD0 is selected.

The LSB is always sent first. See "Command Descriptions," page 6 for detailed descriptions of commands used to set these values.

Table 17: Binary Bottom-Track Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the bottom-track data identification word (00 06h).
5-8	3,4	BP / BT # Pings	Stores the BP-command. If BP = zero, the ADCP does not collect bottom-track data. The ADCP automatically extends the ensemble interval (TE) if BP x TP > TE.
9-12	5,6	Reserved	Reserved

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Table 17: Binary Bottom-Track Data Format (continued)

Hex Digit	Binary Byte	Field	Description
13,14	7	BC / BT Corr Mag Min	Stores the minimum correlation magnitude value (BC-command). Scaling: LSD = 1 count; Range = 0 to 255 counts
15,16	8	BA / BT Eval Amp Min	Stores the minimum evaluation amplitude value (BA-command). Scaling: LSD = 1 count; Range = 1 to 255 counts
17,18	9	Reserved	Reserved – always 0
19,20	10	BM/BT Mode	Stores the bottom-tracking mode (BM-command).
21-24	11,12	BE/BT Err Vel Max	Stores the error velocity maximum value (BE-command). Scaling: LSD = 1 mm/s; Range = 0 to 5000 mm/s (0 = did not screen data)
25-32	13–16	Reserved	Reserved
33-48	17-24	BT Range / Beam #1-4 BT Range	Contains the two lower bytes of the vertical range from the ADCP to the sea bottom (or surface) as determined by each beam. This vertical range does not consider the effects of pitch and roll. When bottom detections are bad, BT Range = 0. See bytes 78 through 81 for MSB description and scaling. Scaling: LSD = 1 cm; Range = 0 to 65535 cm
49-64	25-32	BT Velocity / Beam #1-4 BT Vel	The meaning of the velocity depends on the EX (coordinate system) command setting. The four velocities are as follows: a) Beam Coordinates: Beam 1, Beam 2, Beam 3, Beam 4 b) Instrument Coordinates: 1->2, 4->3, toward face, error c) Ship Coordinates: Stbd, Fwd, Upward, Error d) Earth Coordinates: East, North, Upward, Error
65-72	33-36	BTCM / Beam #1-4 BT Corr.	Contains the correlation magnitude in relation to the sea bottom (or surface) as determined by each beam. Bottom-track correlation magnitudes have the same format and scale factor as water-profiling magnitudes.
73-80	37-40	BTEA / Beam #1-4 BT Eval Amp	Contains the evaluation amplitude of the matching filter used in determining the strength of the bottom echo. Scaling: LSD = 1 count; Range = 0 to 255 counts
81-88	41-44	Reserved	Reserved
89-100	45-50	Reserved	Reserved
101-140	51-70	Reserved	Reserved
141-144	71,72	BX / BT Max. Depth	Stores the maximum tracking depth value (BX-command). Scaling: LSD = 1 decimeter; Range = 80 to 9999 decimeters

Table 17: Binary Bottom-Track Data Format (continued)

Hex Digit	Binary Byte	Field	Description
145-152	73-76	RSSI/Bm #1-4 RSSI Amp	Contains the Receiver Signal Strength Indicator (RSSI) value in the center of the bottom echo as determined by each beam. Scaling: LSD˜ ≈ 0.45 dB per count; Range = 0 to 255 counts
153,154	77	GAIN	Contains the Gain level for shallow water. See WJ-command.
155-162	78-81	BT Range MSB / Bm #1-4	Contains the most significant byte of the vertical range from the ADCP to the sea bottom (or surface) as determined by each beam. This vertical range does not consider the effects of pitch and roll. When bottom detections are bad, BT Range=0. See bytes 17 through 24 for LSB description and scaling. Scaling: LSD = 65,536 cm, Range = 65,536 to 16,777,215 cm

5.8 Binary Fixed Attitude Data Format

BIT POSITIONS

BYTE	7 6 5 4 3 2	1 0	
1	FIXED ATTITUDE ID	00h	LSB
2		30h	MSB
3–10	Attitude Output Coordinates and Processing Control using Interpolated Attitude (EE)		
11	External Pitch/Roll Scaling (EF)		
12–14	Fixed Heading Scaling (EH)		
15–16	Roll Misalignment (EI)		
17–18	Pitch Misalignment (EJ)		
19–23	User Input for Pitch, Roll, and Coordinate Frame (EP)		
24	User Input for Up/Down Orientation (EU)		
25–26	User Input for Heading Bias/Variation/Synchro Offset (EV)		
27 ↓ 34	Sensor Source (EZ)		

Figure 12. Binary Fixed Attitude Data Format

NOTE. This data is always output in this format.

Fixed Attitude data refers to the dynamic ADCP data (from heading, pitch, and roll sensors) that change with each ping. The ADCP will output Fixed Attitude data as output data (LSBs first). See "Command Descriptions," page 6 for detailed descriptions of commands used to set these values.

Table 18: Binary Fixed Attitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	FAID / Fixed Attitude ID	Stores the Fixed Attitude identification word (00 30h).
5-20	3-10	Attitude Output Coordinates	Stores the setting of the EE command; a user input for the Variable Attitude data to be output.
21,22	11	External Pitch/Roll Scaling	Stores the setting of the EF command; a user input for scaling the external synchro input for pitch and roll.
23-28	12-14	Fixed Heading Scaling	Stores the setting of the EH command; a user input for heading.
29-32	15,16	Roll Misalignment	Stores the setting of the EI command; a user input for the roll misalignment.
33-36	17,18	Pitch Misalignment	Stores the setting of the EJ command; a user input for the pitch misalignment.
37-46	19-23	Pitch, Roll and Coordinate Frame	Stores the setting of the EP command; a user input for the pitch, roll, and coordinate (instrument or ship) frame.
47,48	24	Orientation	Stores the setting of the EU command; a user input for the up/down orientation.
49-52	25,26	Heading Offset	Stores the setting of the EV command; a user input for the heading offset due to heading bias, variation, or synchro initialization.
53-68	27-34	Sensor Source	Stores the setting of the EZ command; a user input defining the use of internal, external, or fixed sensors.

5.9 Binary Variable Attitude Data Format

BYTE	BIT POSITIONS 7 6 5 4 3 2 1 0	
1	VARIABLE ATTITUDE ID	LSB
2	3040 - 30FC	MSB
3	Heading Water/Bottom Ping Type 1	LSB
4		MSB
5	Pitch Water/Bottom Ping Type 1	LSB
6		MSB
7	Roll Water/Bottom Ping Type 1	LSB
8		MSB
9	Heading Rate Water/Bottom Ping Type 1	LSB
10		MSB
11	Pitch Rate Water/Bottom Ping Type 1	LSB
12		MSB
13	Roll Rate Water/Bottom Ping Type 1	LSB
14		MSB
15	Heading Water/Bottom Ping Type 2	LSB
16		MSB
17	Pitch Water/Bottom Ping Type 2	LSB
18		MSB
19	Roll Water/Bottom Ping Type 2	LSB
20		MSB
21	Heading Rate Water/Bottom Ping Type 2	LSB
22		MSB
23	Pitch Rate Water/Bottom Ping Type 2	LSB
24		MSB
25	Roll Rate Water/Bottom Ping Type 2	LSB
26		MSB
↓	(Sequence Continues up to 8 Water/Bottom Ping Types)	↓
75	Heading Water/Bottom Ping Type 7	LSB
76		MSB
77	Pitch Water/Bottom Ping Type 7	LSB
78		MSB
79	Roll Water/Bottom Ping Type 7	LSB
80		MSB

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BIT POSITIONS

BYTE	7	6	5	4	3	2	1	0	
81	Heading Rate Water/Bottom Ping Type 7								LSB
82									MSB
83	Pitch Rate Water/Bottom Ping Type 7								LSB
84									MSB
85	Roll Rate Water/Bottom Ping Type 7								LSB
86									MSB
87	Heading Water/Bottom Ping Type 8								LSB
88									MSB
89	Pitch Water/Bottom Ping Type 8								LSB
90									MSB
91	Roll Water/Bottom Ping Type 8								LSB
92									MSB
93	Heading Rate Water/Bottom Ping Type 8								LSB
94									MSB
95	Pitch Rate Water/Bottom Ping Type 8								LSB
96									MSB
97	Roll Rate Water/Bottom Ping Type 8								LSB
98									MSB

Figure 13. Binary Variable Attitude Data Format

NOTE. The number of Water/Bottom Ping Types varies based on the setting of the EE, WP, NP, and BP commands.

Fixed Attitude data refers to the dynamic ADCP data (from heading, pitch, and roll sensors) that change with each ping. The ADCP will output Fixed Attitude data as output data (LSBs first). See "Command Descriptions," page 6 for detailed descriptions of commands used to set these values.

The Variable Attitude identification word varies depending on the setting of the EE, NP, WP BP, and BK commands. See Table 19, page 73 for details on which ID to expect based on these command settings.

Table 19: Variable Attitude Identification Word

EE bits ab	#HPR (WP_{NB})	#HPR (WP_{BB})	#HPR (BP_{BB})	#HPR (WM_{BB})	Data Type ID
00	X	X	X	X	No Output
Instrument					
01	0	0	0	0	3040h
01	0	0	0	1	3044h
01	0	0	1	0	3048h
01	0	0	1	1	304Ch
01	0	1	0	0	3050h
01	0	1	0	1	3054h
01	0	1	1	0	3058h
01	0	1	1	1	305Ch
01	1	0	0	0	3060h
01	1	0	0	1	3064h
01	1	0	1	0	3068h
01	1	0	1	1	306Ch
01	1	1	0	0	3070h
01	1	1	0	1	3074h
01	1	1	1	0	3078h
01	1	1	1	1	307Ch
Ship					
10	0	0	0	0	3080h
10	0	0	0	1	3084h
10	0	0	1	0	3088h
10	0	0	1	1	308Ch
10	0	1	0	0	3090h
10	0	1	0	1	3094h
10	0	1	1	0	3098h
10	0	1	1	1	309Ch
10	1	0	0	0	30A0h
10	1	0	0	1	30A4h
10	1	0	1	0	30A8h
10	1	0	1	1	30ACh
10	1	1	0	0	30B0h
10	1	1	0	1	30B4h
10	1	1	1	0	30B8h
10	1	1	1	1	30BCh
Instrument and Ship					
11	0	0	0	0	30C0h
11	0	0	0	2	30C4h
11	0	0	2	0	30C8h
11	0	0	2	2	30CCh
11	0	2	0	0	30D0h
11	0	2	0	2	30D4h
11	0	2	2	0	30D8h
11	0	2	2	2	30DCh
11	2	0	0	0	30E0h
11	2	0	0	2	30E4h
11	2	0	2	0	30E8h
11	2	0	2	2	30ECh
11	2	2	0	0	30F0h
11	2	2	0	2	30F4h
11	2	2	2	0	30F8h
11	2	2	2	2	30FCh

Table 20: Binary Variable Attitude Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	VAID / Variable Attitude ID	Stores the Variable Attitude identification word (range 3040 to 30FC, see Table 19, page 73).
5-8	3,4	Heading Water/Bottom Ping Type 1	Stores the Heading value for the first Ping Type recorded. A Ping Type is defined based on the EE command setting and then on the NP, WP, BP, and BK commands. The EE command decides if the heading data for this Ping Type will be relative to the Instrument or Ship coordinate. The NP, WP, BP, and BK commands decide if the heading data for this Ping Type will be for the Narrow Bandwidth Water Ping, the Broad Bandwidth Water Ping, the Bottom Track Ping, or the Bottom Water Reference Layer Ping.
9-12	5,6	Pitch Water/Bottom Ping Type 1	Stores the Pitch value for the first Ping Type recorded. A Ping Type is defined based on the EE command setting and then on the NP, WP, BP, and BK commands. The EE command decides if the pitch data for this Ping Type will be relative to the Instrument or Ship coordinate. The NP, WP, BP, and BK commands decide if the pitch data for this Ping Type will be for the Narrow Bandwidth Water Ping, the Broad Bandwidth Water Ping, the Bottom Track Ping, or the Bottom Water Reference Layer Ping.
13-16	7,8	Roll Water/Bottom Ping Type 1	Stores the Roll value for the first Ping Type recorded. A Ping Type is defined based on the EE command setting and then on the NP, WP, BP, and BK commands. The EE command decides if the roll data for this Ping Type will be relative to the Instrument or Ship coordinate. The NP, WP, BP, and BK commands decide if the roll data for this Ping Type will be for the Narrow Bandwidth Water Ping, the Broad Bandwidth Water Ping, the Bottom Track Ping, or the Bottom Water Reference Layer Ping.
17-20	9,10	Heading Rate Water/Bottom Ping Type 1	Stores the Heading Rate value for the first Ping Type recorded. A Ping Type is defined based on the EE command setting and then on the NP, WP, BP, and BK commands. The EE command decides if the heading rate data for this Ping Type will be relative to the Instrument or Ship coordinate. The NP, WP, BP, and BK commands decide if the heading rate data for this Ping Type will be for the Narrow Bandwidth Water Ping, the Broad Bandwidth Water Ping, the Bottom Track Ping, or the Bottom Water Reference Layer Ping.
21-24	11,12	Pitch Rate Water/Bottom Ping Type 1	Stores the Pitch Rate value for the first Ping Type recorded. A Ping Type is defined based on the EE command setting and then on the NP, WP, BP, and BK commands. The EE command decides if the pitch rate data for this Ping Type will be relative to the Instrument or Ship coordinate. The NP, WP, BP, and BK commands decide if the pitch rate data for this Ping Type will be for the Narrow Bandwidth Water Ping, the Broad Bandwidth Water Ping, the Bottom Track Ping, or the Bottom Water Reference Layer Ping.

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Table 20: Binary Variable Attitude Data Format (continued)

Hex Digit	Binary Byte	Field	Description
25-28	13,14	Roll Rate Water/Bottom Ping Type 1	Stores the Roll Rate value for the first Ping Type recorded. A Ping Type is defined based on the EE command setting and then on the NP, WP, BP, and BK commands. The EE command decides if the roll rate data for this Ping Type will be relative to the Instrument or Ship coordinate. The NP, WP, BP, and BK commands decide if the roll rate data for this Ping Type will be for the Narrow Bandwidth Water Ping, the Broad Bandwidth Water Ping, the Bottom Track Ping, or the Bottom Water Reference Layer Ping.
29-196	15-98	Ping Types 2-8 if used	Repeat of the previous 12 bytes for each Ping type. NOTE: Ping Types are defined in the order of NP, WP, BP, and BK. Ping Type 1 output will be the first command that is greater than 1. That is, if NP>1 and WP=0 then Ping Type 1 will be for the value for the Narrow Bandwidth Water Ping. If NP=0 and WP>0 then Ping Type 1 will be for the value for the Broad Bandwidth Water Ping. The first command setting in the order of NP, WP, BP, and BK that is greater than zero becomes Ping Type 1. Then based on the EE command this data may be relative to the instrument or to the ship. If both instrument and ship are selected by the EE command then the Ping Type 1 will be instrument and Ping Type 2 will be ship.

5.10 Binary Navigation Data Format

BIT POSITIONS

BYTE#	7 6 5 4 3 2 1 0	
1	NAVIGATION ID 00h	LSB
2	20h	MSB
3	UTC DAY	
4	UTC MONTH	
5	UTC YEAR	LSB
6		MSB
7	UTC TIME OF FIRST FIX	LSB
8		
9		
10		MSB
11	PC CLOCK OFFSET FROM UTC	LSB
12		
13		
14		MSB
15	FIRST LATITUDE	LSB
16		
17		
18		MSB
19	FIRST LONGITUDE	LSB
20		
21		
22		MSB
23	UTC TIME OF LAST FIX	LSB
24		
25		
26		MSB
27	LAST LATITUDE	LSB
28		MSB
29		LSB
30		MSB
31	LAST LONGITUDE	LSB
32		MSB
33		LSB
34		MSB

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35	AVG SPEED	LSB
36		MSB
37	AVG TRACK TRUE	LSB
38		MSB
39	AVG TRACK MAGNETIC	LSB
40		MSB
41	SPEED MADE GOOD	LSB
42		MSB
43	DIRECTION MADE GOOD	LSB
44		MSB
45	RESERVED	
46		
47	FLAGS	
48		
49	RESERVED	
50		
51	ADCP ENSEMBLE NUMBER	LSB
52		
53		
54		MSB
55	ADCP ENSEMBLE YEAR	LSB
56		MSB
57	ADCP ENSEMBLE DAY	
58	ADCP ENSEMBLE MONTH	
59	ADCP ENSEMBLE TIME	
60		
61		
62		
63	PITCH	LSB
64		MSB
65	ROLL	LSB
66		MSB
67	HEADING	LSB
68		MSB

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69	NUMBER OF SPEED AVG	LSB
70		MSB
71	NUMBER OF TRUE TRACK AVG	LSB
72		MSB
73	NUMBER OF MAG TRACK AVG	LSB
74		MSB
75	NUMBER OF HEADING AVG	LSB
76		MSB
77	NUMBER OF PITCH/ROLL AVG	LSB
78		MSB

Figure 14. Binary Navigation Data Format

NOTE. This data is output in this format only by the VmDas program in the STA and LTA data files.

These fields contain the Navigation Data. This data is only recorded in the STA and LTA files created by the RDI Windows software program *VmDas*. The LSB is always sent first. See “Command Descriptions,” page 6 for detailed descriptions of commands used to set these values.

Table 21: Binary Navigation Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	ID Code	Stores the sum of velocities identification word (2000h).
5-6	3	UTC Day	This field contains the UTC Day.
7-8	4	UTC Month	This field contains the UTC Month.
9-12	5,6	UTC Year	This field contains the UTC Year, i.e. i.e. 07CF = 1999
13-20	7-10	UTC Time of first fix	UTC time since midnight; LSB = 0.01 seconds
21-28	11-14	PC Clock offset from UTC	PC Time – UTC (signed); LSB = milliseconds

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Table 21: Binary Navigation Data Format (continued)

Hex Digit	Binary Byte	Field	Description

29-36	15-18	First Latitude	This the first latitude position received after the previous ADCP ping.
			
			LSB=approx. 8E-8 deg (32-bit BAM)
			
			In the BAM (Binary Angular Measure) format, the most significant bit of the word has a weight of 180 degrees, and you keep dividing by 2 as you proceed to the right. The lease significant bit for a 32-bit BAM is about 8E-8 arc degrees ($180/2^{31}$), or just under 1 cm of longitudinal distance at the equator, where 1 arc minute = 1 Nautical mile. If you interpret the BAM word as an unsigned number, the range is 0 to (360-lsb) degrees, and if you interpret the BAM as a signed number, the range is –180 to (180-lsb) degrees. The least significant bit for a 16-bit BAM is about 0.0055 degrees ($180/2^{15}$). Some 32-bit BAM examples are:
			
			UNSIGNED
			`0x40000000   90 degrees`
			`0x80000000  180 degrees`
			`0xC0000000  270 degrees`
			`0xFFFFFFFF  360 degrees minus one LSB degrees`
			SIGNED
			`0x40000000   90 degrees`
			`0x80000000  minus 180 degrees`
			`0xC0000000  minus 90 degrees`
			`0xFFFFFFFF  minus one LSB degrees`

37-44	19-22	First Longitude	This is the first longitude position received after the previous ADCP ping. LSB=approx. 8E-8 deg (32-bit BAM)
45-52	23-26	UTC Time of last fix	Time since midnight UTC; LSB=1E-4 seconds
53-60	27-30	Last Latitude	This is the last latitude position received prior to the current ADCP ping. LSB=approx. 8E-8 deg (32-bit BAM)
61-68	31-34	Last Longitude	This is the last longitude position received prior to the current ADCP ping. LSB=approx. 8E-8 deg (32-bit BAM)
69-72	35,36	Avg Speed	Average Navigational Speed mm/sec (signed)
73-76	37,38	Avg Track True	Average True Navigational Ship Track Direction LSB=approx. 0.0055 deg (16-bit BAM)
77-80	39,40	Avg Track Magnetic	Average Magnetic Navigational Ship Track Direction LSB=approx. 0.0055 deg (16-bit BAM)

Table 21: Binary Navigation Data Format (continued)

Hex Digit	Binary Byte	Field	Description
81-84	41,42	Speed Made Good (SMG)	Speed calculated between navigation positions. LSB=one mm/sec (signed) The Speed Made Good (SMG) and Direction Made Good (DMG) quantities are calculated from the navigation fixes that enter the system between ADCP outputs, and are calculated as follows: If: aLat(i) = the average of the latitudes of the nav fixes in interval i aLon(i) = the average of the longitudes of the nav fixes in interval i Ta(i) = the average of the time of validity of the nav fixes in interval i dLat = the difference in average latitude between averaging intervals dLon = the difference in average longitude between averaging intervals VelMGn (i) = the velocity made good in the North direction for interval i VelMGe (i) = the velocity made good in the East direction for interval i LatToDist (dLat) is a function that converts delta Latitude to a distance LonToDist (dLon) is a function that converts delta Longitude to a distance Smg (i) = speed made good in interval i Dmg (i) = direction made good in interval i Then: dLat = (aLat (i-1) – aLat (i)) dLon = (aLon (i-1) – aLon (i)) VelMgn (i) = LatToDist (dLat) / (Ta(i-1) – Ta(i)) VelMge (i) = LonToDist (dLon) / (Ta(i-1) – Ta(i)) Smg(i) = sqrt(VelMGn(i)^2 + VelMGe(i)^2) Dmg(i) = atan(VelMGe(i) / VelMGn(i))
85-88	43,44	Direction Made Good (DMG)	Direction calculated between navigation positions. LSB = approx. 0.0055 deg (16-bit BAM)
89-92	45,46	Reserved	Reserved for RDI use.

Table 21: Binary Navigation Data Format (continued)

Hex Digit	Binary Byte	Field	Description
93-96	47,48	Flags	Describes the validity of the data. Each bit has represents a separate flag and has its own meaning 1=true, 0=false. The flag bits are defined as follows: bit 0 = Data updated bit 1 = PSN Valid bit 2 = Speed Valid bit 3 = Mag Track Valid bit 4 = True Track Valid bit 5 = Date/Time Valid bit 6 = SMG/DMG Valid bit 7 = Pitch/Roll Valid bit 8 = Heading Valid bit 9 = ADCP Time Valid bit 10 = Clock Offset Valid bit 11 = Reserved bit 12 = Reserved bit 13 = Reserved bit 14 = Reserved bit 15 = Reserved
97-100	49,50	Reserved	Reserved for RDI use.
101-108	51-54	ADCP Ensemble Number	This field contains the sequential number of the ensemble to which the data in the output buffer apply. Scaling: LSD = 1 ensemble; Range = 1 to 4,294,967,296 ensembles
109-112	55,56	ADCP Ensemble Year	This field contains the ADCP year, i.e. 07CFH = 1999
113-114	57	ADCP Ensemble Day	This field contains the ADCP day.
115-116	58	ADCP Ensemble Day	This field contains the ADCP month.
117-124	59-62	ADCP Ensemble Time	Number of seconds since midnight; LSB = 0.01 seconds
125-128	63,64	Pitch	Pitch angle. LSB = approx. 0.0055 deg (16-bit BAM). Pitch is positive when bow is higher than stern.
129-132	65,66	Roll	Roll angle. LSB =approx. 0.0055 deg (16-bit BAM). Roll is positive when the port side is higher than the starboard side.
133-136	67,68	Heading	Heading input. LSB =approx. 0.0055 deg (16-bit BAM)
137-140	69,70	Number of Speed Samples Averaged	The number of speed samples averaged since the previous ADCP ping.
141-144	71,72	Number of True Track Samples Avg	The number of True Track samples averaged since the previous ADCP ping.
145-148	73,74	Number of Magnetic Track Samples Avg	The number of Magnetic Track samples averaged since the previous ADCP ping.
140-152	75,76	Number of Heading Samples Averaged	The number of Heading samples averaged since the previous ADCP ping.

Table 21: Binary Navigation Data Format (continued)

Hex Digit	Binary Byte	Field	Description
153-156	77,78	Number of Pitch/Roll Samples Averaged	The number of Pitch/Roll samples averaged since the previous ADCP ping.

5.11 Binary Reserved BIT Use

BIT POSITIONS

BYTE	7	6	5	4	3	2	1	0
1	RESERVED FOR RDI USE							
2								

Figure 15. Binary Reserved BIT Use

NOTE. This data is always output in this format.

Table 22: Binary Reserved for RDI Format

Hex Digit	Binary Byte	Field	Description
1-28	1-2	Reserved for RDI's use	This field is for RDI (internal use only).

5.12 Binary Checksum Data Format

BIT POSITIONS

BYTE	7	6	5	4	3	2	1	0	
1	CHECKSUM DATA								LSB
2									MSB

Figure 16. Binary Checksum Data Format

NOTE. This data is always output in this format.

Table 23: Binary Checksum Data Format

Hex Digit	Binary Byte	Field	Description
1-4	1,2	Checksum Data	This field contains a modulo 65536 checksum. The ADCP computes the checksum by summing all the bytes in the output buffer excluding the checksum.

6 How to Decode an ADCP Ensemble

Use the following information to help you write your own software.

6.1 Rules for the BroadBand Data Format PD0

a. All data types (i.e. fixed leader, variable leader, velocity, echo intensity, correlation, percent good, etc.) will be given a specific and unique ID number. The table below shows some of the most common IDs.

Table 24: Common Data Format IDs

ID[1]	ID[2]	Description
7F7F	7F7F	Header
0000	0001	Fixed Leader
0080	0081	Variable Leader
0100	0101	Velocity Profile Data
0200	0201	Correlation Profile Data
0300	0301	Echo Intensity Profile Data
0400	0401	Percent Good Profile Data
0500	0501	Status Profile Data
0600	0601	Bottom Track Data
2000	2000	Navigation
3000	3000	Binary Fixed Attitude
3040 – 30F0	3040 – 30F0	Binary Variable Attitude

Note 1 – If only WP > 1 _or_ NP > 1

Note 2 – If both WP > 1 _and_ NP > 1

b. Once a data type has been given an ID number and the format of that data has been published we consider the format for each field as being fixed. Fixed refers to units used for a given field, the number of bytes in a given field, and the order in which the fields appear within the data type. Fixed does not refer to the total number of bytes in the data type - see Rule “c”.

c. Data may be added to an existing data type only by adding the bytes to the end of the data format. As an example, the variable leader data contains information on ensemble number, time, heading, pitch, roll, temperature, pressure, etc. The format for the bytes 1-53 are now specified. If additional sensor data is to be added to the variable leader data then it must be added to the end of the data string (bytes 54-x as an example).

d. The order of data types in an ensemble is not fixed. That is there is no guarantee that velocity data will always be output before correlation data.

e. The header data will include the number of data types in the files and the offset to each ID number for each data type.

f. The total number of the bytes in an ensemble minus the 2-byte checksum will be included in the header.

6.2 Recommended Data Decoding Sequence for BroadBand Data Format PD0

a. Locate the header data by locating the header ID number (in the case of PD0 profile data that will be 7F7F).

b. Confirm that you have the correct header ID by:

1. Locating the total number of bytes (located in the header data) in the ensemble. This will be your offset to the next ensemble.
2. Calculate the checksum of total number of bytes in the ensemble excluding the checksum. The checksum is calculated by adding the value of each byte. The 2-byte least significant digits that you calculate will be the checksum.
3. Read the 2-byte checksum word at the end of the ensemble, located by using the checksum offset in the header (determined in step "b-1") and compare this checksum word to the value calculated in step "b-2".
4. If the checksums match then you have a valid ensemble. If the checksums do not match then you do not have a valid ensemble and you need to go back to step "a" and search for the next header ID number occurrence.

c. Locate the number of data types (located in the header data).

d. Locate the offset to each data type (located in the header data).

e. Locate the data ID type you wish to decode by using the offset to each data type and confirm the data ID number at that offset matches the ID type you are looking for.

f. Once the proper ID type has been located, use the ADCP Technical Manual for the ADCP you are using to understand what each byte represents in that particular data type.

6.3 Pseudo-Code for Decoding PD0 Ensemble Data

The following examples show the pseudo-code for decoding PD0 and PD5 ensemble data.

g. Define structures, which contain all fields in all data types of the PD0 format.
   1. typedef struct { <lists of types and fields> } FixedLeader.
   2. typedef struct { <lists of types and fields> } VariableLeader.
   3. typedef struct { <lists of types and fields> } BottomTrack.
   4. typedef struct { <lists of types and fields> } VelocityType
   5. and so on for every available type.

h. Clear checksum.

i. Look for PD0 ID 0x7F. Add to checksum.

j. Is next byte a 0x7F? Add to checksum.

k. If no, return to step “b”.

l. Else, read next two bytes to determine offset to checksum. Add two bytes to checksum.

m. Read in X more bytes, where X = offset to checksum - 4. Adding all bytes to checksum.

n. Read in checksum word.

o. Do checksums equal?

p. If no, return to “b”.

q. For each available data type (the header contains the # of data types), go to the offset list in header.
   1. Create a pointer to type short to the data type at an offset in the list.
   2. Check the Type ID.
   3. Create a pointer of appropriate type to that location.
   4. Repeat for all available data types.

r. Work with data.

s. Return to “b” for next ensemble.

6.4 Pseudo-Code for Decoding PD5 Ensemble Data

a. Define structure that contains all fields in PD5 format.

    1. typedef struct { <lists of types and fields> } PD5_Format.

b. Clear checksum.

c. Look for ID, PD5 id is 0x7D. Add to checksum.

d. Is next byte a 0x01? Add to checksum.

e. If no, return to “b”.

f. Else, read next two bytes to determine offset to checksum. Add two bytes to checksum.

g. Read in X more bytes, where X = offset to checksum - 4. Adding all bytes to checksum.

h. Read in checksum word.

i. Do checksums equal?

j. If no, return to “b”.

k. Create a pointer of type PD5_Format.

    1. PD5_Format *PD5_ptr;

l. Point pointer at location of ID byte.

    1. PD5_ptr = &buf[<location of input buffer>];

m. If “k” and “l” don't appeal to you, you can create a variable of type PD5_Format.

    1. PD5_Format PD5_data;

n. And copy the data from the input buffer to PD5_data.

o. Work with data.

p. Return to “b” for next ensemble.

6.5 Example Code for Decoding BroadBand Ensembles

Here is an example of how to decode a BroadBand ensemble. It is written in “C.”

NOTE. Structures must be “packed”; i.e. Don’t let the compiler add “fill bytes” to align fields on word boundaries.

This is an example of a section of code, not a full executable program.

```
/***************************************************************************/
/* Data ID Words */
/***************************************************************************/

   #define FLdrSelected   0x0000
   #define VLdrSelected   0x0080
   #define VelSelected    0x0100
   #define CorSelected    0x0200
   #define AmpSelected    0x0300
   #define PctSelected    0x0400
   #define SttSelected    0x0500
   #define BotSelected    0x0600
   #define Prm0           0x0700

   #define VelGood        0x0701
   #define VelSum         0x0702
   #define VelSumSqr      0x0703
   #define Bm5VelSelected 0x0A00
   #define Bm5CorSelected 0x0B00
   #define Bm5AmpSelected 0x0C00
   #define AmbientData    0x0C02
   #define Bm5PctSelected 0x0D00
   #define Bm5SttSelected 0x0E00
   #define Prm0_5         0x1300
   #define VelGood_5      0x1301
   #define VelSum_5       0x1302
   #define VelSumSqr_5    0x1303

/***************************************************************************/
/* structures */
/***************************************************************************/

   typedef unsigned char  uchar;
   typedef unsigned short ushort;
   typedef unsigned long  ulong;

   typedef struct {
      uchar        Minute,
                   Second,
                   Sec100;
   }  TimeType;

   typedef struct {
      uchar        Year,
                   Month,
                   Day,
                   Hour,
                   Minute,
                   Second,
                   Sec100;
   }  DateTimeType;

   typedef struct {
      uchar        Version,
                   Revision;
   }  VersionType;

   typedef struct {
      uchar        ID,
                   DataSource;
      ushort       ChecksumOffset;
      uchar        Spare,
                   NDataTypes;
      ushort       Offset [256];
   }  HeaderType;

   typedef struct {
      ushort       ID;
      VersionType  CPUFirmware;
      ushort       Configuration;
      uchar        DummyDataFlag,
                   Lag,
                   NBeams,
                   NBins;
      ushort       PingsPerEnsemble,
                   BinLength,
                   BlankAfterTransmit;
      uchar        ProfilingMode,
```

```
                PctCorrelationLow,
                NCodeRepetitions,
                PctGoodMin;
   ushort       ErrVelocityMax;
   TimeType     TimeBetweenPings;
   uchar        CoordSystemParms;
   short        HeadingAlignment,
                HeadingBias;
   uchar        SensorSource,
                AvailableSensors;
   ushort       DistanceToBin1Middle,
                TransmitLength;
}  FixLeaderType;

typedef struct {
   ushort       ID,
                EnsembleNumber;

   DateTimeType RecordingTime;
   uchar        Spare1;
   ushort       BITResult,
                SpeedOfSound,
                Depth,
                Heading;
   short        Pitch,
                Roll;
   ushort       Salinity;
   short        Temperature;
   TimeType     MaxTimeBetweenPings;
   uchar        HeadingStddev,
                PitchStddev,
                RollStddev;
   uchar        VMeas [8];
}  VarLeaderType;

typedef struct {
   ushort       ID,
                PingsPerEnsemble,
                EnsembleDelay;
   uchar        CorrelationMin,
                AmplitudeMin,
                PctGoodMin,
                BTMode;
   ushort       ErrVelocityMax,
                NSearchPings,
                NTrackPings;
   ushort       Range        [4];
   short        Velocity     [4];
   uchar        Correlation  [4],
                Amplitude    [4],
                PctGood      [4];
   ushort       WaterLayerMin,
                WaterLayerNear,
                WaterLayerFar;
   short        WVelocity    [4];
   uchar        WCorrelation [4],
                WAmplitude   [4],
                WPctGood     [4];
   ushort       MaxTrackingDepth;
   uchar        Amp [4];
   uchar        Gain;
   uchar        RangeMSB [4];
}  BottomTrackType;

typedef struct
{
  ushort        ID;
  short         Data [256];
} OneBeamShortType;

typedef struct
{
  ushort        ID;
  uchar         Data [256];
} OneBeamUcharType;

typedef struct {
   ushort       ID;
```

```
      short        Data [1024];
   }  IntStructType;

   typedef struct {
      ushort       ID;
      uchar        Data [1024];
   }  ByteStructType;

   typedef struct
   {
     ushort        ID;
     uchar         Data [4];
   }  AmbientType;

   typedef struct
   {
     ushort        ID;
     ushort        UaH;
     ushort        UaL;
     ushort        AmbBitsPerBin;
     ushort        AmbTrys;
     ushort        AmbNBins;
     short         AmbBinNum [ 5 ];
     short         Est [ 5 ];
     ushort        WAutoCor [ 5 ] [ 32 ];
     uchar         SysFreq;
     uchar         SampRate;
   }  T01Type;

   typedef struct
   {
     ushort        ID;
     uchar         DAC [36];
   }  T02Type;

   typedef struct
   {
     ushort        ID;
     ushort        RSSIBinLen;
     ushort        RSSIBins;
     uchar         RSSI [512] [4];
     ushort        AutoCor [32] [4];
     short         Est [4];
     ushort        Amb [4];
     uchar         SysFreq;
     uchar         SampRate;
     uchar         MLen;
     ushort        XmtSamples;
     ushort        FirstBin[4];
     ushort        LastBin[4];
     ulong         BM6Depth[4];
     ushort        BM6Ta[4];
   }  T03Type;

/**************************************************************************/
/* Global Pointers */
/**************************************************************************/
   HeaderType       *HdrPtr;
   FixLeaderType    *FLdrPtr;
   VarLeaderType    *VLdrPtr;
   BottomTrackType  *BotPtr;
   BottomTrackType  *WBotPtr;
   IntStructType    *VelPtr;
   ByteStructType   *CorPtr;
   ByteStructType   *AmpPtr;
   ByteStructType   *PctPtr;
   ByteStructType   *SttPtr;
   AmbientType      *AmbientPtr;
   T01Type          *T01Ptr;
   T02Type          *T02Ptr;
   T03Type          *T03Ptr;
   OneBeamShortType *Bm5VelPtr;
   OneBeamUcharType *Bm5CorPtr;
   OneBeamUcharType *Bm5AmpPtr;
   OneBeamUcharType *Bm5PctPtr;
   OneBeamUcharType *Bm5SttPtr;

/*----------------------------------------------------------------------*/
```

```
unsigned char RcvBuff[8192];

void DecodeBBensemble( void )
{
    unsigned short i, *IDptr, ID;

    FLdrPtr = (FixLeaderType *)&RcvBuff [ HdrPtr->Offset[0] ];

    if (FLdrPtr->NBins > 128)
        FLdrPtr->NBins = 32;

    for (i=1; i<HdrPtr->NDataTypes; i++)
    {
        IDptr = (unsigned short *)&RcvBuff [ HdrPtr->Offset [i] ];
        ID = IDptr[0];

        switch (ID)
        {
        case VLdrSelected:
            {
                VLdrPtr = (VarLeaderType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case VelSelected:
            {
                VelPtr = (IntStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case CorSelected :
            {
                CorPtr = (ByteStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case AmpSelected :
            {
                AmpPtr = (ByteStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case PctSelected :
            {
                PctPtr = (ByteStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case SttSelected :
            {
                SttPtr = (ByteStructType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case BotSelected :
            {
                BotPtr = (BottomTrackType*)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        case AmbientData :
            {
                AmbientPtr = (AmbientType *)&RcvBuff [ HdrPtr->Offset [i] ];
                break;
            }
        }
    }
}
```